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Sport Fishery Abstracts

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Sport Fishery Abstracts

An abstracting service for fishery research and management

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Sport Fishery Abstracts is intended to furnish fishery biologists in government agencies and educational institutions with abstracts of the current literature in sport fishery research and management. Abstracts of papers on limnology, ecology, natural history and other fields of specialization will be included when the subject has application to the conservation of sport fish and the restoration of sport fishing.

The symbol (A) following an abstract indicates an author's abstract. Other initials following the abstract are those of abstractors whose names are listed on the last page. If no symbol is given the abstract was prepared by the Editorial staff. One volume consisting of not more than four numbers will be issued each year. Each number contains separate Author and Subject indexes, with the final number of each volume containing cumulative indexes.

The last number of each volume contains a list of publications screened for appropriate material. Suggestions for improving the usefulness and coverage of Sport Fishery Abstracts are solicited.

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Prepared in the Branch of Federal Aid
Robert M. Rutherford, Chief
William R. Beckmann, Editor
Geraldine C. Ewing, Asst. Editor

737. Lindsey, C. C. 1956. DISTRIBUTION AND TAXONOMY OF FISHES IN THE MACKENZIE DRAINAGE OF BRITISH COLUMBIA. J. Fish. Res. Bd. Canada, Vol. 13, No. 6, Nov., pp. 759-789.

New and previously published records are listed for 28 species of fresh-water fishes in tributaries of the Mackenzie River in northern British Columbia. Distribution patterns are discussed for all species reaching the continental divide at the Peace River headwaters; some are restricted to one or other side, but 17 species are common to the Peace and Fraser Rivers, suggesting that mountain ranges have served as a check but not an insurmountable obstacle to postglacial expansion. Five species indigenous to the Pacific slope—Catostomus macrocheilus, Richardsonius balteatus, Ptychocheilus oregonense, Mylocheilus caurinum, and Cottus asper—have evidently penetrated to the Peace River in comparatively recent times. Three species—the flathead chub Platygobio gracilis, the trout-perch Percopsis omiscomaycus, and the spoonhead sculpin Cottus ricei—have not previously been recorded from the province. Evidence is presented that subspecific distinctions are invalid in Couesius plumbeus (Agassiz) and Lota lota (Linnaeus). Coregonus coulteri and Hybognathus hankinsoni are reported for the first time from the Mackenzie drainage. (A)

738. Vladykov, Vadim D. 1956. FECUNDITY OF WILD SPECKLED TROUT (SALVELINUS FONTINALIS) IN QUEBEC LAKES. J. Fish. Res. Bd. Canada, Vol. 13, No. 6, Nov., pp. 799-841.

For the present macroscopic study over 1,000 female speckled trout from the Laurentide Park in Quebec have been examined. Of this number, 747 specimens received special attention. In ovaries of adult trout 3 types of eggs were found: Recruitment stock (Class a), maturing eggs (Class b) and atretic eggs (Class c). In the process of maturation, the number of eggs of Class b progressively decreases due to atresia, but their diameter becomes greater. Comparisons of fecundity between different trout populations should be made only when eggs are nearly mature. The diameter of ripe eggs just previous to spawning, preserved in formalin, varied from 3.8 to 4.8 mm. There is a direct relation between the number of ripe eggs and the size of the fish: The extreme numbers of eggs were 90 and 4,800 eggs, and the extremes of fork lengths of females were 6 and 22 inches. The fecundity is greater among fish from lakes richer in food. A simplified method of determining the number of eggs in ovaries was devised. The maturity of females was determined by a 7-digit system. The color of flesh was classified by a 6-digit system. (A)

739. Andrews, C. W. and E. Lear. 1956. THE BIOLOGY OF ARCTIC CHAR (SALVELINUS ALPINUS L.) IN NORTHERN LABRADOR. J. Fish. Res. Bd. Canada, Vol. 13, No. 6, Nov., pp. 843-860.

Arctic char (Salvelinus alpinus L.) from the commercial sea run were sampled at five stations in northern Labrador. Otoliths were used for age determination. In the southern part of the range—Adlatok and Nain—commercial size is reached at 6 years and at places farther north in 7 years. There is also a tendency for older fish to occur as one proceeds north.

Age, weight, and length frequencies as well as their relationship to one another were determined.

Vertebral counts indicate little, if any, intermingling of populations between: Adlatok and Nain, Okkak Bay and Hebron, Adlatok and Ramah, Nain and Hebron. Fin ray counts conform with the vertebral results but indicate no significant difference between Adlatok and Nain or Nain and Okkak Bay fish.

Variations in flesh color from white to deep red is a distinct characteristic of Arctic char in northern Labrador; flesh color has a distinct bearing on the market value of the fish.

Principal food items included capelin, launce, young of mailed sculpin, Amphipoda, and Euphausiacea. (A)

740. Crossman, E. J. 1956. GROWTH, MORTALITY AND MOVEMENTS OF A SANCTUARY POPULATION OF MASKINONGE (ESOX MASQUINONGY MITCHILL). J. Fish. Res. Bd. Canada, Vol. 13, No. 5, Oct., pp. 599-612.

A Schumacher population estimate based on 995 maskinonge taken by trap nets, between the months of May and October in the years 1951–1953, set the number of maskinonge in Nogies Creek at between 769 and 1,122 in July 1953. The mean standard length of these fish was 53.0 cm. The rate of growth (26.3 cm. S. L. in the first year) compared favorably with that for maskinonge in other waters. Fish of age-groups II, III and IV predominated. The small number of fish over 4 years of age was apparently due to a 70 percent annual mortality rate at least after the third year of life and perhaps before age III.

Recaptures of tagged maskinonge demonstrated that there was little movement of maskinonge in summer, and what movement there was, was mainly upstream. In the fall there was far more movement of fish, and this was mainly in a downstream direction.

The area supports a fairly large population of maskinonge but the high mortality after 3 years of age limits its value for raising maskinonge to legal size. The potential for rearing fish to 3 years of age is such that it may be very advantageous to move hatchery fish here for one or two years before liberation. (A)

741. Watt, Kenneth E. F. 1956. THE CHOICE AND SOLUTION OF MATHEMATICAL MODELS FOR PREDICTING AND MAXIMIZING THE YIELD OF A FISHERY. J. Fish. Res. Bd. Canada, Vol. 13, No. 5, Oct., pp. 613-645.

The great expense of modern fisheries research programs necessitates, prior to data collection, careful consideration of the mathematical model to be used in analysis. The simplest type of model

requires little information, but has poor predictive reliability. Progressively more complex models have higher information output, in the form of predictive reliability and insight into dynamics of the exploited population, but require higher information input, not only as amount of data, but array of types of data. The general form of the most complex type of model is derived by consideration of available information on the dynamics of fish populations. The specific form of the component terms and the values of the parameters must be derived in each instance through a combination of deduction and joint regression analysis. To solve the models, catch-effort data must be weighted to avoid gross errors, all readable scales must be aged, regardless of difficulty in interpretation, and various modifications of the theory and practice of tag-recapture programs are necessary. Schooling behavior and regenerated scale centers influence necessary minimum size of scale sample. (A)

742. Johnson, W. E. 1956. ON THE DISTRIBUTION OF YOUNG SOCKEYE SALMON (ONCORHYNCHUS NERKA) IN BABINE AND NILKITKWA LAKES, B.C. J. Fish. Res. Bd. Canada, Vol. 13, No. 5, Oct., pp. 695-708.

Babine Lake and connected Nilkitkwa Lake, a total lake area of 174 square miles, provide nursery facilities for progeny of the largest sockeye salmon run to the Skeena River in northern British Columbia.

Based on catch per unit of fishing effort, tow-net collections in August and October, 1955, indicate that at least 67 percent, and possibly as much as 88 percent, of the total age 0 sockeye population of these lakes (estimated as 50 to 60 million) was concentrated in Nilkitkwa Lake and the North Arm of Babine Lake: That is, in 11.4 percent of the total lake area. Mean size of young sockeye in these areas of concentration was much smaller than in the sparsely populated remainder of Babine Lake.

This unequal distribution of young sockeye, and resulting inefficient utilization of the lake nursery facilities, is apparently a result of the distribution of the spawning parent population and a limited dispersal of young sockeye from their points of entrance into the lake as fry. (A)

743. Nutt, David C. and Lawrence K. Coachman. 1956. THE OCEANOGRAPHY OF HEBRON FJORD, LABRADOR. J. Fish. Res. Bd. Canada, Vol. 13, No. 5, Oct., pp. 709-758.

Hebron Fjord, extending some 28 miles into the northeast coast of Labrador at about latitude 58°10' N., and having a sill at depth of 59 m. across its mouth, was visited at various periods during 1949, 1952 and 1954. The present paper deals with the oceanographic regime and physical environment in the fjord and adjacent coastal waters. Data on tides and currents, and on contributions of fresh water from precipitation run-off and ice melting are given. Oceanographic factors discussed include temperature, salinity, dissolved oxygen, inorganic phosphate, temperature-salinity relationships, and long-term trends. Ice formation as an oceanographic phenomenon is considered. Computations of thermohaline convection are made, and the effects of ice formation and exchange in determining the winter oceanographic structure are discussed. Above sill depth exchange occurs principally by horizontal movements and a flushing time of about 68 days is computed. Below sill depth exchange must involve vertical movements and occurs principally by convection in winter. Calculations of the A factors of eddy conductivity and eddy diffusivity are made. Dynamic computations of water transport are given. During winter a water temperature of −1.75° C. exists at all levels in the fjord, rising in summer only to −1.68° at 250 m. and −1.00° at 100 m., causing the bottom waters to remain an isolated pocket of high Arctic environment during the summer and fall seasons as contrasted with the disappearance of negative temperatures down to 120 m. by mid-October outside the fjord. Inorganic phosphate increases with depth; photosynthesis maintains oxygen at super-saturation above 30 m. during summer, and the rate of oxygen consumption and renewal by vertical transport below 80 m. is calculated. (A)

744. Van Campen, Wilvan G. and Earl E. Hoven. 1956. TUNAS AND TUNA FISHERIES OF THE WORLD: AN ANNOTATED BIBLIOGRAPHY, 1930-53. U. S. Fish and Wildlife Service Fish. Bull. No. 111, from Vol. 57, pp. 173-249.

This bibliography attempts to list, with descriptive annotations and a subject index, important literature published between 1930 and 1953 dealing with the tunas and their fisheries in all parts of the world. It is thus a continuation of Corwin's (1930) work, which extended with similar scope through 1929, and an extension of Shimada's (1951), which was limited to the biology of Pacific tunas. The tunas with which it deals are those fishes customarily so-called in commercial parlance and usually classified in the genera Thunnus, Neothunnus, Parathunnus, Germo, Katsuwonus, Euthynnus, and Auxis and their various synonyms. All aspects of the biology of the tunas are dealt with, as are descriptions and histories of all types of tuna fisheries, commercial and exploratory tuna fishing methods and results, fishing gear, catch statistics, and fishery management, but processing technology, economics and marketing, folklore, and purely literary references have been excluded. (A)

745. Séguin, Richard L. 1956. LIMITES GEOGRAPHIQUES ET FACTEURS CLIMATIQUES DE LA DISTRIBUTION NATURELLE DE LA TRUITE MOUCHETÉE. Reprint from Revue canadienne de Géographie, Vol. 10, No. 2-3, April-Sept., pp. 113-117.

The speckled trout (Salvelinus fontinalis) is indigenous only to the northeast of North America. In Canada it is found throughout the Maritime Provinces, Labrador and Quebec, as well as in the greater part of Ontario and as far west as Manitoba. In the United States it is likewise generally distributed through the New England States and New York, in the Appalachians as far south as Georgia,

above 2,000 feet in altitude, and in some places in the States of Minnesota, Wisconsin, Iowa, Illinois, Ohio, Pennsylvania, New Jersey, Maryland, the Virginias, the Carolinas and Tennessee. The area of distribution of the speckled trout, which is delimited to the north and east by the Arctic and the Atlantic Ocean respectively, is just as decisively delimited in the west where the line marking the annual surplus precipitation becomes less than 4 inches of water, and in the south by the line where the mean temperature for the summer months rises above 70° F. (A)

746. Jackson, C. F. 1956. CONTROL OF THE COMMON SUNFISH OR PUMPKINSEED, LEPOMIS GIBBOSUS IN NEW HAMPSHIRE. N. H. Fish and Game Dept. Tech. Cir. No. 12, 16 pgs.

Experiments conducted at the University of New Hampshire under the auspices of the Engineering Experiment Station demonstrated the feasibility of using sodium hydroxide to control the common sunfish, Lepomis gibbosus. The method developed consists in placing pellets of sodium hydroxide, one inch in diameter, in the nests of the sunfish when eggs or fry are present. Experiments showed that eggs and fry are killed in from 3 to 5 minutes in a concentration of 5 parts per million. The pellets cost about 3 to 4 cents to treat 16 nests. Life history and spawning habits were investigated in reference to this method of control. Equipment and methods used are explained. (A)

747. Phillips, Arthur M., Jr., Floyd E. Lovelace, Henry A. Podoliak, Donald R. Brockway, and George C. Balzer, Jr. 1956. THE NUTRITION OF TROUT (Cortland Hatchery Report No. 24, for the year 1955). U. S. Fish and Wildlife Service Fish Res. Bull. No. 19, 56 pgs.

The research program of the Cortland Experimental Hatchery for the year 1955, consists of four independent studies. Three of these studies are a continuation of previous work and the fourth is a new undertaking.

The absorption of minerals from food and water by brook trout has been studied by means of radioactive tracers. The absorption of cobalt from water is a valid index of metabolic activity. Both high water temperature (51° F.) and low calcium (5 ppm.) cause an increase in cobalt absorption. Significant amounts of cobalt are deposited in the gastro-intestinal tract of trout. The gills are the site of absorption.

Starving brook trout absorb less calcium from water than feeding trout. After 1 week of starvation the metabolic activity of the fish (as measured by calcium absorption) is greater than after 3 weeks. The distribution in the body of calcium absorbed from water is influenced by the dietary level and vice versa. Brook trout absorb more calcium from low level than from high level calcium diets. The osmoregulatory function of calcium is confirmed.

A chemical comparison of hatchery and wild brook trout indicates that wild fish are superior. More true flesh production (ash and protein) is found in the bodies of wild trout. A comparison of protein conversions speculates that natural food is more efficient than hatchery food. The protein conversion for hatchery food is twice that of natural food.

A chemical embryological study of developing brown trout eggs has shown changes in protein, fat, and water content during incubation. The ash and iodine number of the fat remain unchanged. The wet weight of the egg decreases during incubation. Explanations are offered for the results.

The need of brown trout for the vitamins inositol, B_{12}, pyridoxine, niacin choline, riboflavin, folic acid, and biotin are established. (A)

748. Gehringer, Jack W. 1956. OBSERVATIONS ON THE DEVELOPMENT OF THE ATLANTIC SAILFISH ISTIOPHORUS AMERICANUS (CUVIER) WITH NOTES ON AN UNIDENTIFIED SPECIES OF ISTIOPHORID. U. S. Fish and Wildlife Service Fish. Bull. No. 110, of Vol. 57, pp. 139-171.

One hundred and sixty-nine istiophorids ranging from 3.4 to 625 mm. in standard length, from the western North Atlantic and the Gulf of Mexico, were examined. Separation to species was not accomplished for specimens below 10 mm. long. Above 10 mm., the Atlantic sailfish, Istiophorus americanus (Cuvier), was readily separated from an unidentified species on length of snout.

A developmental series, 3.6 to 374 mm., representing a combination of istiophorids below 10 mm. and the sailfish above 10 mm., is figured, described, and discussed. Several of the unidentified specimens are also figured. Growth and development of various body parts are discussed, with emphasis on the sailfish. Three stages of larval development are suggested: "early larval," below 7 mm.; "midlarval," the 7 to 20 mm. range; and "late larval," the 20 to 100 mm. range.

Analyses of stomachs of 32 specimens revealed: copepods comprised the food of specimens smaller than 6 mm., but were not present in those exceeding 13 mm.; and fish larvae comprised the bulk of food in specimens exceeding 6 mm.

Spawning seasons and areas suggested are as follows: Western North Atlantic, April to September, from south of Cuba north to the Carolinas, beyond the 100-fathom line, and closely associated with the Gulf Stream; eastern Gulf of Mexico, April through August; western Gulf, June into August. Surface salinity, oxygen, and temperature values for locations of capture of some istiophorid larvae are given.

It is suggested that the unidentified specimens are more likely to develop into the adult form of the spearfish, Tetrapturus, than into the sailfish, Istiophorus, or the marlins, Makaira. (A)

749. Bryant, Floyd G. 1956. STREAM SURVEYS OF THE SHEEPSCOT AND DUCKTRAP RIVER SYSTEMS IN MAINE. U. S. Fish and Wildlife Service Special Scientific Rep.-Fish. No. 195, Dec., 19 pgs.

As part of a cooperative program to restore Atlantic salmon in Maine, the Fish and Wildlife Service and the Maine Sea Run Salmon Commission

made stream surveys to collect information on obstructions to fish, pollution, water temperature, stream flow, and extent of spawning and rearing areas.

In the Sheepscot River system it was found that 14 out of 52 tributaries were seriously obstructed, and 20 had insufficient flows for salmon. Only 3 tributaries were considered to be of any value as salmon spawning and rearing areas. In addition to a very small number of salmon, a few shad, striped bass and alewives are found in the watershed. The abatement of pollution and the creation of adequate flows and passages for fish migration is recommended.

The Ducktrap River was found to have limited potentialities for salmon, the most inimical feature being low stream flows. Out of 19 tributaries, 4 were obstructed and 16 had flows too small for salmon. Only 2 were considered to have any value for salmon spawning and rearing. Provision of adequate passage facilities and the augmentation of flows is recommended. (A)

750. Smith, Stanford H. 1956. LIFE HISTORY OF LAKE HERRING OF GREEN BAY, LAKE MICHIGAN. U. S. Fish and Wildlife Service Fish. Bull. 109, of Vol. 57, pp. 87-138.

Although the lake herring has been an important contributor to the commercial fish production of Green Bay, little has been known about it.

This study is based on field observations and data from about 6,500 lake herring collected over the period 1948 to 1952. Relatively nonselective commercial pound nets were a primary source of material for the study of age and growth. Commercial and experimental gill nets were used to obtain data on gear selectivity and vertical distribution.

Scales were employed to investigate age and growth. Age group IV normally dominated commercial catches during the first half of the calendar year and age group III the last half. At these ages the fish averaged about 10.5 inches in length. The season's growth started in May, was most rapid in July, and terminated near the end of October. The sexes grew at the same rate. Selectivity of fishing gear was found to influence the estimation of growth. Geographical and annual differences in growth are shown. Factors that might contribute to discrepancies in calculated growth are evaluated. Possible real and apparent causes of growth compensation are given.

The relation between length and weight is shown to vary with sex, season, year, and method of capture.

Females were relatively more plentiful in commercial catches in February than in May through December. The percentage of females decreased with increase in age in pound-net catches but increased with age in gill-net samples. Within a year class the percentage of females decreased with increase in age.

Most Green Bay lake herring mature during their second or third year of life. They are pelagic spawners with most intensive spawning over shallow areas. Spawning takes place between mid-November and mid-December, and eggs hatch in April and May. Lake herring ovaries contained from 3,500 to 11,200 eggs (averaged 6,375). Progress of spawning by age, sex, and length is given.

Lake herring were distributed at all depths in Green Bay in early May, were concentrated within 30 feet of the surface in late May, moved to deeper water in June, and were restricted to depths greater than 30 feet in July when temperatures in shallower water became unfavorably high (greater than 18° C.). In October, lake herring were again at all depths but were most abundant near the surface. (A)

751. Walburg, Charles H. 1956. COMMERCIAL AND SPORT SHAD FISHERIES OF THE EDISTO RIVER SOUTH CAROLINA. U. S. Fish and Wildlife Service Special Scientific Rep-Fish. No. 187, Oct., 9 pgs.

The Edisto River, South Carolina, shad fishery was investigated to determine fishing effort, fishing rate, total catch, size of run, and spawning escapement for 1955. The commercial fishery catch-and-effort data were obtained from logbooks kept by each fisherman. The total catch made by sport fishing was determined by a post-card survey. The catch-and-effort data were combined with a tagging and recovery program, and it was estimated that the fishing rate was approximately 20 percent, the total catch was 11,000 shad, and the size of run was 56,000 shad (fiducial limits 28,000 to 100,000). Unfortunately, catch-and-effort records for previous years were not available for this stream; therefore, sizes of former runs and escapements could not be determined.

It is concluded that the State of South Carolina should establish a system of collecting yearly catch- and effort records on the Edisto River. If these records are obtained for a period of years, an intensive study, similar to that conducted in 1955, can be made to determine factors affecting shad abundance. (A)

752. Shomura, Richard S. and Tamio Otsu. 1956. CENTRAL NORTH PACIFIC ALBACORE SURVEYS, JANUARY 1954 - FEBRUARY 1955. U. S. Fish and Wildlife Service Special Scientific Rep. - Fish. No. 173, June, 29 pgs.

This report embodies the fishing results from seven exploratory cruises in the North Pacific during the one fall and two winter seasons between January 1954 and February 1955. These results are supplemented by Japanese commercial longline catch data for the same period.

Albacore, Germo alalunga (Bonnaterre), were caught during all three seasons on longlines and were taken by trolling only during the fall and second winter. The longline-caught albacore covered a wider size range than did the troll-caught fish. There appears to be a parallel north-south shift with the seasons of the albacore population and the transition zone between the North Pacific Current and the Aleutian Current. During the winter both were located south of their fall positions. Also included in this report are discussions of the vertical

distribution, sex composition, and tagging of albacore as well as data on the miscellaneous species of fish taken. (A)

753. Iversen, Edwin S. 1956. SIZE VARIATION OF CENTRAL AND WESTERN PACIFIC YELLOWFIN TUNA. U. S. Fish and Wildlife Service Special Scientific Rep.-Fish. No. 174, June, 23 pgs.

This analysis of the size frequencies of long-line-caught yellowfin tuna, Neothunnus macropterus (Temminck and Schlegel), is based on weight data collected in the Honolulu market from 1948 to 1953 for Hawaiian waters, and on measurements taken aboard research vessels from 1951 to 1954 for the central equatorial Pacific and aboard Japanese tuna motherships in 1950 and 1951 for the western equatorial Pacific. The modes which occur in the size-frequency distributions for these three areas are all in similar positions, but certain modal groups present in the Hawaiian material are frequently or consistently missing from the central and western equatorial samples. In both the Hawaiian and equatorial areas there are no important differences in the size composition from year to year.

Smaller yellowfin (100-130 pounds) enter the Hawaiian fishery in June and July, and the larger fish (over 130 pounds) appear in August and September. Progression of the modes in the Hawaiian samples indicates growth, with the rate slackening in the latter half of each year. No such modal progression appears in the data from equatorial waters. Male yellowfin in Hawaiian waters attain greater size than do the females, and they usually make up about 64 percent of the fish taken by longline. Similar sex ratios and size differences between the sexes are found in the samples from equatorial areas. (A)

754. Kennedy, W. A. 1956. THE FIRST TEN YEARS OF COMMERCIAL FISHING ON GREAT SLAVE LAKE. Bull. No. 107 of the Fish. Res. Bd. of Canada, 58 pgs.

Great Slave Lake contains 10,430 square miles of water. It was opened to commercial fishing in 1945, and has been fished continuously since. Fishing is done exclusively with bottomset gill-nets of $5\frac{1}{2}$-inch stretched mesh, set both during the summer, and during winter under the ice. The fish caught are predominantly lake trout, Cristivomer namaycush, and lake whitefish, Coregonus clupeaformis. These are taken in about equal quantities in summer, but relatively more whitefish are taken in winter. The 10-year catch was 24 million pounds of trout and nearly 36 million pounds of whitefish. Production has increased over the years, the 1954 catch being 2,389,000 pounds of trout and 4,490,000 pounds of whitefish. Other species amount to about 5 percent of the combined trout and whitefish catch, and include burbot, ciscoes, suckers, inconnu, pike, and walleye.

Data on catch per net for the summer season were collected by daily interviews with more than half the fishermen. Average sizes at various times and places were determined from representative samples that totalled 88,928 trout and 122,639 whitefish, or about 1,000,000 pounds out of a total commercial catch of 59,000,000 pounds over the 10 years 1945-54. The following factors were used to convert dressed weights of individual fish to round weights: whitefish, gills and viscera removed, 1.1765; trout, gills and viscera removed, 1.2048; trout, head and viscera removed, 1.6667.

The average round weight of the trout taken was 7.9 pounds in 1945 and 6.3 pounds in 1954, having fluctuated irregularly in the interim. Whitefish varied from 3.1 pounds in 1945 to 2.6 pounds in 1954, again with irregular variations. Catch per net has decreased by about 45 percent for trout and by about 30 percent for whitefish, but it is still high for both species, by comparison with long-fished lakes. There seems to be a trend toward stabilization of both average size and catch per net, at values lower than the original.

Catch per net proved to be a rather poor index either for estimating changes in the stock of one species or for comparing the relative abundance of different species. It varies from place to place and from year to year, and it is a function (inverse) of the number of nets fished. The change in average size is probably a better indicator of change in abundance, but it too has fluctuated erratically, so that only trends over a period of years have significance. The decreases in catch per net and average size which have occurred are unavoidable results of having a fishery, and there are no indications that they have yet reached undesirably low levels. The amount of fishing done (about 1/200 as much as in Lake Erie) is far from excessive, and catch per net night is still large.

Several lines of evidence suggest that trout spawn more successfully in the eastern half of the lake and that whitefish spawn more successfully in the western half. It appears that each summer the larger trout and whitefish concentrate in deeper (colder) water than do smaller ones. Nylon gill-nets did not catch appreciably more fish than comparable cotton gill-nets. (A)

755. Godfrey, H., W. R. Hourston, and F. C. Withler. 1956. BABINE RIVER SALMON AFTER REMOVAL OF THE ROCK SLIDE. Bull. No. 106 of the Fish. Res. Bd. of Canada, 41 pgs.

The Babine River rock slide, which was an obstruction to salmon in 1951 and 1952, was removed during the winter of 1952-53, and the site permitted free passage to salmon in 1953. An estimate of the Babine sockeye escapement in 1953, based on the size of the commercial catch, was within 2500 fish (+0.3 percent) of the actual escapement counted at the fence just below Babine lake. This, incidentally, provides confirmation of estimates of losses at the Slide in 1951 and 1952.

In 1953, about 90 percent of tags applied to sockeye below the site of the former obstruction were recovered at the fence, about 40 miles up river. The 1953 Babine sockeye run was large—more than 700,000. Fish were in good condition, arrived at the fence at the normal time, and were normal in respect to sex ratios and sexual maturity, in contrast to the abnormality in these respects of

the runs in 1951 and 1952. Further, there were no abnormal losses in unspawned fish observed on the Babine Lake spawning grounds in 1953: approximately 95 percent of a large sample of dead females had spawned successfully.

The number of sockeye smolts migrating from Babine Lake in 1954 was estimated as 2.8 millions. These represented a survival rate from the potential egg deposition in 1952 of 0.69 percent, as compared with rates of 0.48, 0.77 and 1.52 for the seedings of 1949, 1950 and 1951, respectively. However, the probable number of eggs actually deposited in 1952 was much smaller after deducting estimated losses in unspawned females on the beds. The 2.8 million smolts represent 1.46 to 2.03 percent of this estimated deposition. (A)

756. Cushing, John E., Jr. 1956. OBSERVATIONS ON SEROLOGY OF TUNA. U. S. Fish and Wildlife Special Scientific Rep.-Fish. No. 183, Oct., 14 pgs.

The present paper presents observations showing that individual variations exist among the erythrocyte antigens of oceanic skipjack, and that species variations exist among other tunas. Further, data are presented concerned with techniques and antigenic specificities that might be profitably applied to racial studies in tunas and other fish. (A)

757. King, Joseph E. and Isaac I. Ikehara. 1956. COMPARATIVE STUDY OF FOOD OF BIGEYE AND YELLOWFIN TUNA IN THE CENTRAL PACIFIC. U. S. Fish and Wildlife Service Fish. Bull. 108, of Vol. 57, pp. 61-85.

Stomachs of 166 bigeye tuna (Parathunnus sibi) and 439 yellowfin tuna (Neothunnus macropterus), captured in the central Pacific by longline fishing, were analyzed quantitatively to determine whether there were differences in the food which might help explain differences in the horizontal and vertical distribution of the tunas. This study provides the first comprehensive report on the food for the bigeye tuna.

Representatives of 48 fish families and 11 invertebrate orders were found among the stomach contents of the yellowfin, as compared with 36 fish families and 9 invertebrate orders for the bigeye. Food items of major importance to both species were pomfret (Collybus drachme), snake mackerel (Gempylus serpens), and squid of the families Ommastrephidae and Loliginidae. Notable differences were the complete lack of stomatopods in the food of bigeye, whereas they were common in yellowfin, and the insignificance of juvenile tunas in the food of bigeye, as compared with their prominence in the food of yellowfin.

In both tunas, the smaller individuals consumed a greater proportion by volume of crustaceans and fish and a lesser proportion of mollusks than the larger size group. In both tunas there was a tendency for the volume of stomach contents to increase with depth of capture, but there was no marked variation in food composition over the range of depth sampled. In the bigeye the volume of stomach contents varied directly with the longline catch rate, while in the yellowfin there was little change in volume of stomach contents even with a marked change in catch rate.

Despite these differences, the foods of yellowfin and bigeye were remarkably similar. When occupying the same general area, the two species were found to have essentially the same feeding habits. (A)

758. Cable, Louella E. 1956. VALIDITY OF AGE DETERMINATION FROM SCALES, AND GROWTH OF MARKED LAKE MICHIGAN LAKE TROUT. U. S. Fish and Wildlife Service Fish. Bull. 107, of Vol. 57, pp. 1-59.

Scales of 1,603 lake trout, Salvelinus n. namaycush, presumably recoveries from plantings of juveniles previously marked by clipping certain fins, were studied. Their characteristics are described and illustrated. Age readings from the scales are highly reliable. In addition to the annuli, an accessory mark designated the O-mark, was found in the field of first-year growth. Annulus formation occurs over a period of several months.

Data presented show that most, probably all, of the 102 specimens caught in the southern part of Lake Michigan and a considerable number (86) of those captured in the northern part actually were from wild stock.

In general, the lake trout caught in large-mesh nets were larger fish than those taken in small-mesh nets. The fin-clipped lake trout caught in all nets were slightly larger than the wild stock of the same year classes, but wild lake trout of the earlier year classes, inhabitants of the lake before sea lampreys became numerous, were even larger and faster growing than the fin-clipped fish. The larger fish of the several year classes, caught in nets of either mesh-size, were taken from the northern part of Lake Michigan and smaller fish from the southern part of the lake. (A)

759. Kilby, John D. 1955. THE FISHES OF TWO GULF COASTAL MARSH AREAS OF FLORIDA. Tulane Studies in Zool., Vol. 2, No. 8, May 4, pp. 175-247.

A study was made of the fish faunas of two coastal marshes on the Gulf Coast of Florida to determine, primarily, the composition of those faunas and to discover, if possible, the more obvious ecological factors which were shaping them.

The two areas were different ecologically. The one at Bayport had less saline waters and more stable temperatures than the one at Cedar Key in addition to other differences which were described.

Seventy-five species were recorded during the study and species data are presented in an annotated list. This treatment is supplemented by tables, graphs, and other compilations designed to present certain of the data which could be summarized. (A)

760. Lowe, Mildred Eileen. 1956. DOMINANCE-SUBORDINANCE RELATIONSHIPS IN THE CRAWFISH CAMBARELLUS SHUFELDTII. Tulane Studies in Zool., Vol. 4, No. 5, Dec. 31, pp. 139-

170.

The crawfish Cambarellus shufeldtii established four-ranked and eight-ranked dominance orders under laboratory conditions. These heirarchies were based on tension contacts. As animals remained together over a period of time, active fighting decreased and the subordinate animals retreated from an attack without defending themselves.

In general, larger animals were dominant over smaller. Either males or females dominated mixed groups. Females carrying eggs were aggressive and dominated their groups, whether composed of males or of females without eggs. When these females lost the young, they became less active and often dropped to lower rank.

When a claw was removed from the dominant animal of a group which had been organized only five days this animal dropped to low rank. If a claw was removed from the dominant after the order was well established and fighting occurred infrequently, this animal often retained its high rank.

When hiding places in the form of shells were provided the dominant animal moved about actively and usually obtained a hiding place any time it tried. Lower-ranking crawfish often remained under shells until forced out by another animal. Second- and third-ranking individuals each could defend a hiding place from attack by the other but not from attack by the dominant. The movements of the lowest-ranking animal were greatly inhibited. It remained in one place until attacked, and often gave up its position without defending itself. (A)

761. Johnson, Malcolm C. and J. R. Fielding. 1956. PROPAGATION OF THE WHITE SHRIMP, PENAEUS SETIFERUS (LINN.), IN CAPTIVITY. Tulane Studies in Zool., Vol. 4, No. 6, Dec. 31, pp. 175-190.

In 1954 and 1955, sexually mature white shrimp, Penaeus setiferus (Linn.), that had been reared or held in dirt ponds, spawned viable eggs when placed in a concrete tank filled with salt water. The resulting larvae were reared through the metamorphic stages and to a pre-adult length of approximately 50.0 mm. in the same facility.

The metamorphic forms could be identified by the descriptions of Pearson (1939); no additional stages were observed. The metamorphic period lasted 12 and 10 days in the 2 years respectively. Upon becoming postlarvae the young shrimp grew at a daily rate of 2.1 mm. in 1954 and 1.7 mm. in 1955.

Observations on the captive larvae, juvenile, and adult shrimp are discussed where appropriate to a better understanding of the life history of P. setiferus. (A)

762. Simpson, Don G. and Gordon Gunter. 1956. NOTES ON HABITATS, SYSTEMATIC CHARACTERS AND LIFE HISTORIES OF TEXAS SALT WATER CYPRINODONTES. Tulane Studies in Zool., Vol. 4, No. 4, Dec. 31, pp. 116-134.

Sixty stations were set up between the Rio Grande and the Sabine River, covering the habitats of the salt water Cyprinodontes along the bay shores, sloughs and tidal ponds. These were visited 84 times, about one and a half rounds of all stations, between September 1950 and March 1951. Drags were made at each station with a 50-foot minnow seine with mesh one quarter of an inch stretched. Water temperatures were taken and salinities were determined later by hydrometer. Some samples were checked by titration. All cyprinodonts captured were counted and measured. Sexual condition and coloration were noted and some stomach contents were noted. External meristic counts were made.

In order of abundance the nine species taken were: Cyprinodon variegatus, Fundulus grandis, Mollienesia latipinna, Fundulus similis, Adinia multifasciata, Gambusia affinis, Lucania parva, Fundulus pulvereus and F. jenkinsi. There were 8,859 of the first taken and only 24 of the last. C. variegatus was almost three times as abundant as all other species together. C. variegatus, F. grandis and F. similis are fairly abundant on open shores, while the others are found mostly in protected waters. As a whole, the cyprinodonts are more inhabitants of sloughs and ponds than bay shores and they are extremely rare on the Gulf beach. Due to a severe drought the salinities at many stations were quite high and in drying ponds they were about 80 percent. Only Gambusia affinis and F. jenkinsi were not taken at salinities higher than 30 percent; F. grandis, F. similis and C. variegatus were sometimes caught, the latter quite abundantly, at salinities above 80 percent and on one occasion this fish was taken where the density measurement was equivalent to 142.4 percent saline, calculated as sea water. It is assumed that the fishes taken at extremely high salinities did not select them, but were merely withstanding them after having been caught in drying ponds and sloughs.

Species with lower scale counts were: C. variegatus, Adinia multifasciata, Lucania parva and Mollienesia latipinna; species with higher counts were F. grandis, F. similis and F. pulvereus. The deeper bodied species were C. variegatus, A. multifasciata and M. latipinna; the slimmer species were F. jenkinsi, F. similis and F. pulvereus. The fishes with smallest eyes proportionally were F. grandis and F. similis; the two smallest species, G. affinis and Lucania parva, had the largest eyes. Detailed color markings were given for all species except for the well known C. variegatus. The smallest Mollienesia were taken in September and January and a fish with young nearing full term was taken in late September. Female F. jenkinsi averaged several mm. longer than males. They were found with developing eggs in September and January. The species was taken only at the type locality, Dickinson Bayou. Male and female F. pulvereus were found to be about the same size. The smallest fish were taken in early November. Ripe fish were taken in November, but females with developing eggs were also found in January. F. similis were observed spawning in minute potholes or depres-

sions on the bay shores in July. The smallest fish taken increased from 20 mm. in total length in September to 43 mm. in March. Females were slightly larger than males. Ripe female F. grandis were taken in October and the smallest fish were taken in November. Ripe Adinia were taken in October. The smallest C. variegatus were found in September, October, and November. The territorial defense of males during the breeding season, as previously described by other workers, was observed. Stomachs of two Gambusia contained fish, crustaceans and annelids. Aquatic insects were found in one F. pulvereus stomach and two isopods were found in another. Two F. grandis contained aquatic insects and vegetable matter, and three had incompletely swallowed small Mollienesia. One stomach of Adinia multifasciata contained algal detritus and another contained pieces of a dragonfly. The stomachs of five female C. variegatus contained vegetable matter. (A)

763. Ahlstrom, Elbert H. and David Kramer. 1956. SARDINE EGGS AND LARVAE AND OTHER FISH LARVAE, PACIFIC COAST, 1954. U. S. Fish and Wildlife Service Special Scientific Rep.-Fish. No. 186, Nov., 79 pgs.

Basic data on abundance of sardine eggs and larvae off the Pacific coast in 1954 are given in this report, together with records of abundance of five other species: northern anchovy (Engraulis mordax), jack mackerel (Trachurus symmetricus), hake (Merluccius productus), Pacific mackerel (Pneumatophorus diego), and rockfish (Sebastodes spp.). (A)

764. Woodhead, P. M. J. 1956. THE BEHAVIOR OF MINNOWS (PHOXINUS PHOXINUS L.) IN A LIGHT GRADIENT. The J. of Exp. Biology, Vol. 33, No. 2, June, pp. 257-270.

Minnows, Phoxinus phoxinus, in a light gradient tank were almost constantly active, but were restricted in their movements by light above a certain intensity. The value of the limiting intensity differed for individual fish but lay between 0.2 and 0.002 metre-candles. These values are of the same order as the threshold for light stimulation of the pineal complex in blind minnows, described by Scharrer It is suggested that the pineal might be the receptor for the light limit, and evidence supporting this suggestion is discussed.

Hungry minnows were not limited by light, and spent a considerable percentage of the observation time in the lightest parts of the tank. After feeding they assumed normal limited behavior. In mid-April, prior to spawning, minnows examined in the gradient were extremely active and showed little sign of a light limit. The mean swimming speed of fish in mid-April was 159 percent faster than that of fish observed in December. (A)

765. Jones, F. R. Harden. 1956. THE BEHAVIOR OF MINNOWS IN RELATION TO LIGHT INTENSITY. The J. of Exp. Biology, Vol. 33, No. 2, June, pp. 271-281.

Minnows, Phoxinus phoxinus, kept in a tank were active during the day and quiet at night. Their behavior was reversed if they were given hollow bricks in which they take cover and so avoid bright light. When cover was available they were very active at sunrise and sunset. Minnows kept in continuous darkness exhibited no inherent daily rhythm of locomotory activity. Blind minnows responded to daily variations in light intensity, and were more active at night than during the day. Minnows will not cross a light-dark boundary when the intensity on the light side is greater than 0.17—0.08 metre-candles. A minnow school disperses between intensities of 0.024 and 0.0034 m.c. Minnows catch Daphnia better in bright light than in the dark. The change from visual to 'dark' feeding takes place between 0.0007 and 0.00007 m.c. Minnows appear to avoid bright light by a comparison of intensities if the light-dark boundary is sharp, but they may also respond to light photokinetically. It should be noted that these results, obtained in the laboratory, may not be true for minnows under natural conditions. (A)

766. Lowenstein, Otto. 1956. PRESSURE RECEPTORS IN THE FINS OF THE DOGFISH SCYLLIORHINUS CANICULA. The J. of Exp. Biology, Vol. 33, No. 2, June, pp. 417-421.

The presence of so-called terminal corpuscles in the connective tissues of the fins of Scylliorhinus canicula, first described by Wunderer in 1908, is confirmed. It is demonstrated that they are pressure receptors with a slow rate of adaptation. From their topographic distribution and from their mode of response to mechanical stimulation, it is postulated that the terminal corpuscles serve as proprioceptors in the widest sense of the term by signalling the spatio-temporal patterns of active or passive deformation of the fin. Their topographic distribution makes it possible to distinguish their responses from those of sense endings associated with the muscles or tendons of the fin. (A)

767. Hardisty, M. W. 1956. SOME ASPECTS OF OSMOTIC REGULATION IN LAMPREYS. The J. of Exp. Biology, Vol. 33, No. 2, pp. 431-447.

The mean osmolar concentration (expressed as millemoles of NaCl per liter) of the serum for Lampetra planeri was found to be 110 mM. in the ammocoete and 113 mM. in the adult. For adult L. fluviatilis serum in November the mean osmolar concentration was 143 millemodes and in March 136 mM. In adult planeri the Cl concentration of the body fluids accounted for nearly 90 percent of the total concentration as compared with only 58 percent in the serum of the ammocoete. Adult fluviatilis kept in tap water throughout the winter appeared to show an increase in Cl levels. Evidence has been produced to support the view that the differences observed in water, fat, and Cl content of ammocoete and adult planeri and adult fluviatilis are consequences of the period of starvation preceding sexual maturity. Pronounced seasonal variations have been found in the fat and Cl content of Ammocoetes of planeri.

The osmotic uptake of water has been determined for adults of both species in fresh water. In planeri the rate of uptake for unit body weight is about four times as great as in fluviatilis. Observations have also been made on the osmotic loss of water of ammocoete and adult planeri and of adult fluviatilis in sea water of different concentrations. For unit body weight, osmotic loss of water in planeri is about twice that of fluviatilis. Total losses of Cl have been determined for ammocoete and adult planeri in distilled water and their effects on internal Cl levels have been studied. Observations have also been made on the active uptake of Cl. Acclimatization experiments on ammocoetes and adult planeri and on adult fluviatilis have failed to produce any evidence of regulation in sea water. (A)

768. Hachey, H. B. 1955. WATER REPLACEMENTS AND THEIR SIGNIFICANCE TO A FISHERY. Papers in Mar. Biology and Oceanography, Suppl. to vol. 3 of Deep-Sea Res., pp. 68-73.

Attention has been directed to some of the major and more apparent effects that water replacements may have on various fisheries. It has been indicated that such interchanges may be responsible for the destruction of a fish population or the extension of others. The loss of larvae to scallop and haddock areas has been considered as the result of movements of a water mass; and it is suggested that the availability and catchability of certain species is effected by certain water replacement phenomena. When consideration is given to the cycle of life in the sea, it will be quite evident that many indirect effects may follow from these water replacements. While the processes of long-term replacements are not too well understood, wind action is one of the more apparent major casual factors in short-term replacements. (A)

769. Carruthers, J. N. 1955. SOME VERY SIMPLE DEVICES FOR VARIOUS OCEANOGRAPHICAL USES. Papers in Mar. Biology and Oceanography, Suppl. to Vol. 3 of Deep-Sea Res., pp. 169-177.

An account is given of some very simple ways of determining the underwater courses of suspension and towing lines in respect both of slope and direction. The means employed is to enclose pendulums and compasses within suitable vessels containing hot gelatine solution. These are affixed to the lines whilst the gelatine solution is hot, so that after the cooling which comes from immersion in the sea, the pendulums and compasses become immovably fixed to give the necessary records. It is shown that the devices could serve very usefully in studies of the pelagic trawl, and could be adapted to determine the shape of trawling cables leading all the way down into the greatest ocean depths. (A)

770. Riley, Gordon A. 1955. REVIEW OF THE OCEANOGRAPHY OF LONG ISLAND SOUND. Papers in Mar. Biology and Oceanography, Suppl. to Vol. 3 of Deep-Sea Res., pp. 224-238.

Long Island Sound is a shallow, semi-enclosed body of slightly brackish (23-31 percent) water with an area of about 900 nautical square miles. Moderate tidal currents permit a small seasonal thermocline and slight vertical gradients in salinity, oxygen and nutrient salts. The major feature of non-tidal circulation is a two-layered transport system in which a freshened surface layer moves eastward out of the Sound and is replaced by a more saline inflow along the bottom. The latter contains more nutrients than the outflowing surface water, so that the transport system tends to accumulate and conserve nutrients. Fresh water drainage also makes a significant contribution of nitrate.

Phytoplankton concentrations are large, but the species composition is relatively limited. A large diatom flowering occurs in late winter, following an early winter minimum, with only minor fluctuations the rest of the year. There is sufficient mixing to prevent a large accumulation of nutrients in the bottom water, so that there is neither pronounced poverty in summer nor a big autumn flowering following destruction of the thermocline. Major limiting factors are the amount of effective light in autumn and winter and the nitrogen supply in spring and summer. Variations in light and temperature from one year to the next affect the winter species composition and the time of the flowering. Diatoms are largely replaced in summer by naked flagellates and other nannoplankton. During one summer when nitrate concentrations were higher than usual, diatoms were abundant and there was also an unusually large zooplankton crop. A causal connection is indicated but not well established.

The zooplankton consists of large numbers of small animals. Relatively few species are present. The dominants are two species of the copepod Acartia which alternate seasonally. Descriptive and experimental studies suggest that seasonal replacement is primarily a temperature-controlled competition rather than a direct, lethal temperature effect. Experiments show that the Acartias have high respiratory rates and low grazing rates compared with most other copepods that have been examined and possibly are able to achieve dominance only in waters sufficiently brackish to exclude more efficient oceanic species.

Preliminary studies of bottom fauna indicate a relatively large biomass, again consisting of large numbers of small animals. Fish eggs and larvae are abundant, and the Sound may be an important spawning and nursery ground. However, commercial fishery statistics show no indications of a large population of mature fish.

Total phytoplankton production is about the same as in the open coastal and bank waters off New England. Most of this production is utilized in the support of small animals which do not provide an adequate food supply for the efficient production of large carnivores. (A)

771. Romer, Alfred Sherwood. 1955. FISH ORIGINS—FRESH OR SALT WATER? Papers in Mar. Biology and Oceanography, Suppl. to Vol.

3 of Deep-Sea Res., pp. 261-280.

There are discussed various general considerations entering into palaeontological study of the problem as to whether the early evolution of fishes took place in fresh or salt water. Opposite conclusions as to the typical habitat of Silurian fishes have been reached by the author and Grove on American evidence, on the one hand, and Gross, mainly concerned with European material, on the other. An attempt is made to reconcile this difference. Part may be due to the very different histories of the two continents in Silurian times. Close examination of the stratigraphy of European fossil fish localities suggests that many deposits which are often regarded as marine are of continental or near-continental nature. It is concluded that the evidence, taken as a whole, points strongly towards fresh waters as the common Silurian fish habitat. (A)

772. Griffin, Donald R. 1955. HEARING AND ACOUSTIC ORIENTATION IN MARINE ANIMALS. Papers in Mar. Biology and Oceanography, Suppl. to Vol. 3 of Deep-Sea Res., pp. 406-417.

The evidence that underwater sound is important in the behavior of fishes and cetaceans is reviewed, with emphasis on the possible occurrence of acoustic orientation. Both of these groups of marine animals have now been shown to have excellent hearing. At least one fish has a minimum auditory threshold of the same order of magnitude as the typical human threshold at 2000-4000 c.p.s. (about 10^{-16} watt/cm^2 energy flux). Porpoises can hear sounds of moderate intensity at frequencies well above 100 kc. A series of recordings which may have resulted from a deep sea fish engaged in echo-sounding are analyzed and discussed, and the possible role of echolocation in marine animals is compared with the available evidence of its nature and occurrence in bats and other animals relying on airborne sound. In this connection the possible usefulness of continuous sounds and standing wave patterns is discussed with reference to the observed fact that a low frequency sound in a small tank undergoes marked fluctuations in intensity over distances that are a small fraction of its wave-length in water. (A)

773. Tåning, Å. Vedel. 1955. ON THE BREEDING AREAS OF THE SWORDFISH (XIPHIAS). Papers in Mar. Biology and Oceanography, Suppl. to Vol. 3 of Deep-Sea Res., pp. 438-450.

The Danish oceanographic expeditions with the Research Steamer Dana and other ships have obtained about 60 postlarval stages of Xiphias (between 5 and 46 mm. in length) from all oceans. Most of these, however, were taken in the western North Atlantic.

The distribution of the smallest stages (i.e. smaller than 20 mm. in length) indicates that an important breeding area lies north and northeast of the Lesser Antilles in the southern part of the Sargasso Sea. Breeding areas are also indicated by records of small postlarvae west of Sumatra, in the South China Sea, in the Celebes and Banda Seas off the Marquesas.

Some spawning occurs during all seasons, but maximal spawning seems to take place during February-April in the North Atlantic. Spawning probably takes place at the same season in the western Pacific, but it occurs later in the year in the Mediterranean owing to the special temperature conditions there. The fry are usually found in water of about 24° C. or higher. They are generally captured between the surface and a depth of about 30 metres. The material at hand seems to show a growth rate of about 8 cms. during the first year, but sufficient material is not yet available for an accurate determination of the growth rate. The fry preferably feed on fish larvae up to nearly the same size as the small voracious Xiphias larva itself. Figures are given of three developmental stages and outline charts show where fry have been taken. Fishing for swordfish may be possible (by floating lines) in the main spawning area in the western North Atlantic. (A)

774. Edmondson, W. T. 1955. FACTORS AFFECTING PRODUCTIVITY IN FERTILIZED SALT WATER. Papers in Mar. Biology and Oceanography Suppl. to vol. 3 of Deep-Sea Res., pp. 451-464.

The response of phytoplankton populations to added nutrients was studied by filling large out-of-door concrete tanks with sea water, and adding phosphate and nitrate. In general there was an immediate increase in photosynthesis and in growth of the population. In some cases, but not all, addition of phosphate alone was ineffective.

A large part of the variation in photosynthetic rate over a 40-day period is attributable to variation in the amount of light falling on the tanks, in the chlorophyll content of the phytoplankton, and in the phosphate concentration in the water. Large variations in the qualitative composition of the population had no apparent effect on this relation. The efficiency of the population in using light varied directly with the amount of fertilizer added, but not in proportion to it. Addition of nutrients to the bottles in which measurements of photosynthesis were made permitted evaluation of limiting factors.

The rate of phosphorus absorption, measured either as decrease of phosphate in the water or increase of phosphorus in particulate form, was directly related to the rate of photosynthesis. (A)

775. Dow, Willard. 1955. UNDERWATER TELEMETERING. Deep Sea Res., Vol. 2, No. 2, Jan., pp. 145-151.

This report describes an inexpensive telemetering depth meter capable of determining depth of towed gear and other information, and of transmitting the data acoustically through the water to the surface. The device is somewhat unusual in that it uses the ocean rather than the air as the metering medium. Built into a torpedo-shaped fish for towing purposes, the instrument is self-contained and may be quickly attached to any trawl wire. (A)

776. Thompson, Thomas G. and Tsaihwa J. Chow. 1955. A NON-METALLIC WATER SAMPLER. Deep-Sea Res., Vol. 2, No. 3, April, pp. 200-203.

A syringe type water sampler made of Lucite is designed for collecting sea water at any depth without the sample becoming contaminated by contact with the metal. The sampler has been used with success in the investigation of trace metallic ions in the ocean. (A)

777. deSylva, Donald P. 1955. THE OSTEOLOGY AND PHYLOGENETIC RELATIONSHIPS OF THE BLACKFIN TUNA, THUNNUS ATLANTICUS (LESSON). Bull. of Mar. Sci. of the Gulf and Caribbean, Vol. 5, No. 1, March, pp. 1-41.

Comparisons with five other species of the genus Thunnus were made to determine the relationships and phylogenetic position of T. atlanticus and its correct taxonomic identity. From osteological evidence, T. atlanticus is intermediate with T. sibi and T. albacares and is slightly closer to the latter. The splitting of the genus Thunnus as proposed in the past by various authors is osteologically unsubstantiated in view of the compactness of the group formed by the six species of Thunnus and their closer relationships to each other than to any of the neighboring genera (Katsuwonus, Euthynnus, Sarda) with which Thunnus was compared. It is therefore suggested that the names Parathunnus, Neothunnus and Germo be incorporated with the genus Thunnus. (A)

778. Hoffman, Glenn L. 1955. NEASCUS NOLFI N. SP. (TREMATODA: STRIGEIDA) FROM CYPRINID MINNOWS WITH NOTES ON THE ARTIFICIAL DIGEST RECOVERY OF HELMINTHS. Amer. Midland Nat., Vol. 53, Jan.-Apr., pp. 198-204.

A new strigeid metacercaria Neascus nolfi, from the creek chub, Semotilus a. atromaculatus, and shiner, Notropis cornutus frontalis, is described.

Neascus nolfi, gasterostome metacercariae, and a distome metacercaria in the stomach mucosa of the chub do not survive pepsin digest whereas Uvulifer (Neascus) ambloplitis, Posthodiplostomum minimum, Ornithodiplostomum ptychocheilus, Diplostomulum corti, Fibricola cratera, and an unidentified distome metacercaria in the musculature of the bullhead do survive for varying lengths of time. The adult helminths, Phyllodistomum sp., Allocreadium lobatum, and Rhabdochona cascadilla can be freed from mucus and mucosa by 10 to 15-minute exposure to pepsin solutions.

A key to the strigeid metacercariae of North American fish is presented. (A)

779. Cole, Gerald A. 1955. AN ECOLOGICAL STUDY OF THE MICROBENTHIC FAUNA OF TWO MINNESOTA LAKES. The Amer. Midland Nat., Vol. 53, Jan.-Apr., pp. 213-230.

At least 133 species of microscopic animals were recorded from the bottom sediments of two lakes, Crystal Lake in Hennepin County, and Lake Itasca, Clearwater County, Minnesota. Littoral bottoms supported the greatest number of microfaunal species, and many were confined to the one zone. The sand and gravel littoral bottom in Lake Itasca had more species than the gyttja deposits farther lakeward while the soft plant-sapropel sediments near the margins of Crystal Lake contained more species than the sand and marl bottoms at the same depth.

The vertical distribution of organisms in the sediments was studied by sectioning core samples at different levels. Most animals were in the upper centimeter of bottom deposits, but individuals of some species were found below a level of 15 cm. in the sediment. Special attention was devoted to the organisms living in the anaerobic profundal zones of the two lakes. Smaller and less varied populations were found in the hypolimnion of Crystal Lake than in Lake Atasca.

Crystal Lake showed evidence of pollution, its sediments were largely sapropelic, and there was a conspicuous formation of H_2S during the long anaerobic periods in deeper waters. Lake Atasca was a highly productive lake, showing little evidence of pollution, its sediments were largely gyttja, and no H_2S was detected in its summer hypolimnion. (A)

780. Bangham, Ralph V. 1955. STUDIES ON FISH PARASITES OF LAKE HURON AND MANITOULIN ISLAND. Amer. Midland Nat., Vol. 53, Jan.-Apr., pp. 184-194.

In all, a total of 1,667 fish belonging to 53 different species were examined and 1,642 or 98.5 percent carried at least one species of parasite. This high degree of infection is due possibly to the fact that most of the fish were adults and to the high degree that fish carried encysted metacercariae of Diplostomulum. Each fish species examined is listed with information on the number examined, the number infected; the parasites and number of hosts infected with each; and a discussion of degree of infection and distribution.

781. Weisel, George F. 1955. THREE NEW INTERGENERIC HYBRIDS OF CYPRINID FISHES FROM WESTERN MONTANA. Amer. Midland Nat., Vol. 53, Jan.-Apr., pp. 396-411.

Taxonomic characters of the hybrids Mylocheilus caurinum x Ptychocheilus oregonense, Ptychocheilus oregonense x Richardsonius balteatus, and Rhinichthys cataractae x Richardsonius balteatus are described and compared with those of the parent species. The hybrids are recognized as such by their intermediacy in characters that differentiate their parental species. Their identification was confirmed by other criteria such as species being present in the same water, no barrier to choice of spawning grounds or in time of breeding, crowding of breeding fish, etc.

782. Monaco, Lawrence H. and John D. Mizelle. 1955. STUDIES ON MONOGENETIC TREMATODES. XVII. THE GENUS DACTYLOGYRUS. Amer. Midland Nat., Vol. 53, Jan.-Apr., pp. 455-477.

Fifty species of Dactylogyrus, including 9 new

forms, all for North America, are described.

783. Elder, David E. and William M. Lewis. 1955. AN INVESTIGATION AND COMPARISON OF THE FISH POPULATIONS OF TWO FARM PONDS. Amer. Midland Nat., Vol. 53, Jan.-Apr., pp. 390-395.

Two watershed ponds in the same valley in proximity to each other were poisoned and an analysis was made of their fish populations. The two ponds appeared to be similar except for the following differences: 1) The upper pond was more turbid; 2) The upper pond had an area of one-quarter of an acre versus an area of one-half of an acre for the lower pond; 3) The upper pond received some barnyard drainage and during the summers of 1950 and 1951 exhibited a bloom of filamentous algae; 4) The upper pond was constructed in 1942, whereas the lower pond was constructed in 1945.

The differences found in the two populations were as follows: 1) On the basis of pounds of fish recovered per acre, the upper pond appeared to have about twice the carrying capacity of the lower pond; 2) The data indicated that the upper pond had approximately twice the population density of the lower pond; 3) The bluegill and white crappie of the lower pond in some years grew more rapidly than those of the upper pond; 4) The coefficient of condition values for the bluegill and white crappie of the lower pond were higher than the values for the fishes from the upper pond; 5) Young-of-the-year bluegill, largemouth bass, warmouth, and green sunfish were not well represented in the upper pond, whereas young-of-the-year white crappie were well represented. No definite conclusions were drawn as to the possible correlation between the environmental differences and the population differences. (A)

784. Watson, Margaret E., Ray W. Guenther, and Rodney D. Royce. 1956. HEMATOLOGY OF HEALTHY AND VIRUS-DISEASED SOCKEYE SALMON, ONCORHYNCHUS NERKA. Zoologica, Vol. 41, Part 1, Nos. 1 to 6, April 23, pp. 27-37.

Observations of cell types found in the peripheral blood of healthy and virus-diseased sockeye salmon fingerlings (Oncorhynchus nerka) are made with a phase-contrast microscope and reproduced photographically. Cells described include erythrocytes, thrombocytes, lymphocytes, neutrophils, eosinophils, basophils and macrophages.

Two diagnostic characteristics of the virus-diseased fish are: 1) before mortalities occur, degeneration in leukocytes and thrombocytes is made evident by the presence of an intracytoplasmic, highly refractile body which appears as a dark brown pigment granule when viewed with bright-field microscopy; 2) during the severest stage of the infection, extracellular granules of basophils appear, as well as totally degenerated leukocytes and thrombocytes which are only visible with phase-contrast microscopy.

The average percent hematocrit of 68 control fingerlings (30-60 mm. in fork length) was 47. Hematocrit values were determined for fish which had been experimentally and naturally infected with the virus disease. At 4 days after experimental infection, the percent hematocrit rose to an average of 53 (maximum 64); at 6 days, peak mortalities occurred and moribund fish registered a normal percent hematocrit. Hematocrit values fell to a low of 16 percent, by the eighth day after exposure to the virus and then gradually rose to normal by the 27th day. Associated with below normal hematocrit values were erythematous areas at the base of the fins, at the anus or the isthmus. Microscopic blood findings and corresponding hematocrit values were related. Microhematocrit tubes used were capillary pipettes (5-10 lambda). (A)

785. Barrington, E. J. W. and A. J. Matty. 1954. SEASONAL VARIATION IN THE THYROID GLAND OF THE MINNOW, PHOXINUS PHOXINUS L., WITH SOME OBSERVATIONS ON THE EFFECT OF TEMPERATURE. Proc. Zoological Soc. of London, Vol. 124, pp. 89-95.

A quantitative assessment has been made of the height of the cells of the follicular epithelium of the thyroid gland of the Minnow, Phoxinus phoxinus L., as an index of the activity of the gland at different seasons of the year. It is possible, despite the considerable degree of variation which occurs, to demonstrate significant fluctuations which indicate that the activity is at its maximum during the early months, from about February to May, during which period the maturation of the germ cells is known to be completed. The maintenance of minnows at constant temperatures for 57 days gives no evidence of an inverse relationship between temperature and cell-height such as is known to exist in certain homoiotherms, but actually suggests a direct one. It seems unlikely, from the available data, that the thyroid fluctuations can be a response to temperature changes in the environment, and it is concluded that there is an indication in the minnow, as elsewhere in the vertebrates, of some correlation of the activity of the thyroid gland with the phases of the reproductive cycle, the causal basis of which is, however, obscure. (A)

786. Philipson, G. N. 1954-55. THE EFFECT OF WATER FLOW AND OXYGEN CONCENTRATION ON SIX SPECIES OF CADDIS FLY (TRICHOPTERA) LARVAE. Proc. Zoological Soc. of London, Vol. 124, pp. 547-564.

The six species of caddis larvae selected for study were collected from the River Blyth, Northumberland, a small river with alternate shallow swift-flowing and deeper slow-flowing stretches. The species selected were Rhyacophila dorsalis, Wormaldia subnigra and Hydropsyche instabilis from swift water, Anabolia nervosa and Polycentropus flavomaculatus from slow-flowing water and Stenophylax stellatus, a species which is generally distributed. Of these species, Anabolia nervosa and Stenophylax stellatus are case-bearing larvae and Hydropsyche instabilis. Wormaldia subnigra and Polycentropus flavomaculatus spin nets or snares for food collection. Rhythmic

undulatory current-producing movements of the abdomen are made by all the larvae except Rhyacophila dorsalis and Wormaldia subnigra.

The larvae may be arranged in the following ascending order of ability to resist the flow of water when exposed to the full force of the current in an experimental channel: Polycentropus flavomaculatus, Anabolia nervosa, Stenophylax stellatus, Wormaldia subnigra, Rhyacophila dorsalis and Hydropsyche instabilis.

The behavior of the net- and snare-spinning larvae in aquaria showed that Hydropsyche instabilis and Wormaldia subnigra larvae only spin typical nets in flowing water and that the former will spin nets in slower-flowing water than will the latter. Polycentropus flavomaculatus larvae will spin snares in still water.

Oxygen determinations on samples of water from swift- and slow-flowing areas of the River Blyth showed only small differences. Further, under certain circumstances water from swift-flowing reaches may have a lower dissolved oxygen concentration than water from slow-flowing reaches.

The minimum oxygen concentration, ie., at which larvae become immobilized, was determined experimentally for each species in still water. This concentration was relatively high for the swift-water species Rhyacophila dorsalis, Wormaldia subnigra and Hydropsyche instabilis, but in stirred water it was similar to that obtained for the other species in still water.

In Hydropsyche instabilis, Polycentropus flavomaculatus, Stenophylax stellatus and Anabolia nervosa larvae decreasing oxygen concentration tended to increase the number of undulatory abdominal movements. In Hydropsyche instabilis and Polycentropus flavomaculatus larvae the number of movements was reduced by an increase in the rate of stirring of the water.

In conclusion, the importance of water flow in determining the distribution of these larvae is stressed. Larvae unable to withstand the force of the current are unable to inhabit swift waters (Polycentropus flavomaculuatus, Anabolia nervosa). Some larvae are dependent upon current for feeding (Hydropsyche instabilis, Wormaldia subnigra), and larvae readily immobilized at a relatively high oxygen concentration in still waters (Rhyacophila dorsalis, Wormaldia subnigra, Hydropsyche instabilis) can tolerate low oxygen concentrations in flowing water. (A)

787. Ramaswami, L. S. and Arthur D. Hasler. 1955. HORMONES AND SECONDARY SEX CHARACTERS IN THE MINNOW, HYBORHYNCHUS. Physiol. Zool., Vol. 28, pp. 62-68.

The eruption of breeding tubercles in the male minnow Hyborhynchus was considered to be a suitable end-point in assaying different pituitary preparat ons. The females do not develop these tubercles. Unsexed carp pituitary powder, injected in aqueous medium, was found to produce eruption of the tubercles in the male; large specimens in which the tubercles had disappeared after the breeding season developed them with one injection of 0.04 mg. of the powder, the equivalent being taken as 0.07 mg. per 10 gm. of fish. In the medium-sized ones, it required at least four injections administered on alternate days, while in the juveniles five injections brought out the secondary sex character. Pituitary-treated females did not develop the tubercles.

Frog and mammalian (human and sheep) pituitary preparations also produced eruption of the tubercles in males when injected in small doses.

Testosterone propionate produced tubercles in both the male and the female minnows; moreover, the anal papilla was enlarged enormously in the female. This appears to confirm findings of earlier workers that the factors for the development of tubercles are inherently present in the female but the ovarian hormones seem to suppress them. With estrogen (estradiol) the tubercles develop only in the male, and very slight enlargement of the anal region was noticed in both male and female minnows. (A)

788. Orr, Paul R. 1955. HEAT DEATH. I. TIME-TEMPERATURE RELATIONSHIPS IN MARINE ANIMALS. Physiol. Zool., Vol. 28, No. 4, Oct., pp. 290-294.

Heat death curves are presented for two species of Fundulus as well as several other organisms including a gastropod, several echinoderms, and two crustacea. These curves, which indicate the time required to produce heat death in animals at various temperatures under specified criteria of death, all have the same approximate shape and clearly portray that the relation of heat and time in producing death is not a straight-line function.

789. Gaufin, Arden R. and Clarence M. Tarzwell. 1955. ENVIRONMENTAL CHANGES IN A POLLUTED STREAM DURING WINTER. Amer. Midland Nat., Vol. 54, No. 1, July, pp. 78-88.

Studies of the effect of organic waste pollution on Lytle Creek, tributary of Little Miami River, were conducted year round. In the summer months during periods of high temperature and low flow, the septic and recovery zones are shortened, and most of the biochemical oxygen demand is satisfied in a relatively short section of the stream, about 70 percent in 2 miles in Lytle Creek. During the summer, diurnal variations in dissolved oxygen are at a maximum and severe oxygen depletion occurs; the effects of pollution are most evident and the life zones are more clear cut and readily observed. The fauna occurring in the septic and recovery zones are able to exist in the absence of free oxygen, have low oxygen requirements, or have special adaptations for obtaining oxygen. With an abundance of food and an absence of competition from other forms these organisms thrive and build large and distinctive populations.

In the winter months, stream flow in Lytle Creek is greater and more rapid, metabolic activity is at a lower level; life zones become longer or lose their identity, and diurnal variations

in dissolved oxygen are at a minimum, the lowest concentrations never approaching those of summer. The increased rate of flow and shorter retention time in the stream coupled with a slower rate of bacterial action serves to carry higher concentrations of organic material into the lower sections of the stream. As a result of this greater organic content, the pollutional carpet of bacteria, protozoa, and entrapped organic materials which is characteristic of the septic zone in summer, extends further downstream. When severe floods do not occur for considerable periods the pollutional carpet reaches the upper end of the clean water zone of summer.

The introduction of clean water organisms from the tributaries to the main channel of a polluted stream during high winter flows constitutes a factor which should be considered in evaluating the reliability of macro-invertebrates as indicators of stream conditions. Also during the winter months bottom organisms characteristic of the septic and recovery zones during summer may be carried to points further downstream. Riffles in the clean water area may serve to collect organisms normally found in pools or along margins in other sections of the stream. It is apparent, therefore, that some knowledge of the habits, habitats, and life histories of many macro-invertebrates is essential for their effective use as biological indicators of pollution.

Because the composition and abundance of stream populations are determined by environmental conditions which have prevailed or by extremes which have occurred during their life cycle, organisms having an annual life cycle are especially valuable as biological indicators of past environmental conditions. The absence of long life history and clean water forms is much more significant than the presence of short life history and tolerant forms. A knowledge of the habits and environmental requirements of bottom organisms enables the aquatic biologist, by means of a brief qualitative quantitative survey to gain some knowledge of past conditions, the severity and extent of pollution, and the degree of recovery. (A)

790. Linder, Allan D. 1955. THE FISHES OF BLUE RIVER IN OKLAHOMA WITH DESCRIPTIONS OF TWO NEW PERCID HYBRID COMBINATIONS. Amer. Midland Nat., Vol. 54, July-Oct., pp. 173-191.

An annotated list of the fishes of Blue River and a detailed description of two new hybrids, Etheostoma radiosum cyanorum x Etheostoma spectabile subsp. and Etheostoma spectabile pulchellum x Etheostoma whipplei whipplei, are presented.

791. Wilson, Francis H. 1955. LAMPREYS IN THE LAKE CHAMPLAIN BASIN. Amer. Midland Nat., Vol. 54, July-Oct., pp. 168-172.

Observations on three lampreys found in New York streams tributary to Lake Champlain are presented as well as a brief note on effects of dry weather on larvae and metamorphasing adults. The three lampreys are the lake lamprey, Petromyzon marinus, the northern or silver lamprey, Ichthyomyzon unicuspis, and the brook lamprey, Entosphenus lamottenii.

792. Hoar, W. S., M. H. A. Keenleyside, and R. G. Goodall. 1955. THE EFFECTS OF THYROXINE AND GONADAL STEROIDS ON THE ACTIVITY OF SALMON AND GOLDFISH. Canad. J. of Zool., Vol. 33, No. 6, Dec., pp. 428-439.

Goldfish immersed in a solution of thyroxine, testosterone, or stilboestrol are more active than untreated fish. The strength of electrical stimulus required to produce a standard response is also less in similarly treated goldfish. Coho and sockeye salmon yearlings tested with the same hormones and sockeye salmon yearlings treated with dienoestrol or nylestin show a decrease in time required to make a standard response in flowing water. These data are discussed in relation to the appetitive behavior of migrating fishes. (A)

793. Stringer, G. E. and W. S. Hoar. 1955. AGGRESSIVE BEHAVIOR OF UNDERYEARLING KAMLOOPS TROUT. Canad. J. of Zool., Vol. 33, No. 3, June, pp. 148-160.

The aggressive behavior of juvenile Kamloops trout, Salmo gairdneri kamloops, consists of chasing, nipping, retreating, threatening, and fighting. These different components are described. Territorial defence appears to be the end result of this behavior. Aggressiveness disappears at low light intensity when the fish settle to the bottom and remain quiet. A seasonal decline in aggressive behavior seems to occur during the spring. The sign stimulus releasing attack is a moving fish-shaped object approximately the same size as the trout. Dark colors have a stronger releasing value than bright colors. Fins and color patterns do not seem to be involved in the sign stimulus. (A)

794. Nursall, J. R. 1956. THE LATERAL MUSCULATURE AND THE SWIMMING OF FISH. Proc. of the Zoological Soc. of London, Vol. 126, Part 1, Jan., pp. 127-143.

The lateral musculature of the fish-like chordates has been examined in an effort to find reasons for the peculiar pattern of the myomeres. There are three distinct types of myomeres: amphioxine, cyclostomine and piscine. All have in common the function of bending their possessors' bodies from side to side to provide locomotor force. In all cases pull is applied obliquely to the long axis of the body. The myomeres pull at once latero-craniad and latero-caudad to bend the body from its position of equilibrium, or rest, into concavity. If continued, this movement would lead to a condition of instability, in which the vectors of the forces applied would pass across the axis of bending and the body would be distorted. However, the length of the body and its resistance to compression prevents this. Also, during locomotion, restorative forces are developed on the convex side of the body to supplant the original bending movement and the body passes through the equilibrium position to

become concave on the opposite side. These reactions follow one another through myomere after myomere from head to tail along the body of the animal; the result is lateral waves passing rapidly down the body, the reaction of which with the water provides locomotion. Each myomere covers several vertebral segments and succeeding myomeres overlap. This allows the bending to progress smoothly along the body as each myomere affects not only its own section of the body but also those of its neighbors.

The myomeres gain attachment to vertebral centra, neural and haemal spines (or ribs) and the connective tissue septa between these structures. Secondary attachments by means of longitudinal ligaments, formed by the apposition of deep myosepta, often occur, especially among the Chondrichthyes.

The mechanical advantage of a segment of the lateral musculature is very small, but it approaches unity among the tunas. In these fish the muscle is concentrated in the body region, while the caudal peduncle supports long tendons running to the caudal fin.

Intermuscular bones appear in the myosepta of many species of fish. These appear to have been developed in response to stresses and strains set up by the musculature. (A)

795. Clemens, Harold B. 1956. REARING LARVAL SCOMBRID FISHES IN SHIPBOARD AQUARIA. Calif. Fish and Game, Vol. 42, No. 1, Jan., pp. 69-79.

This paper presents the results of an initial attempt to rear young tuna-like fishes in aquaria. Handling techniques, feeding problems, growth, schooling and swimming observations, and space requirements are described. Those "tuna" larvae kept alive for 10 days had increased 11 times in weight and 1-4 times in length.

796. Reish, Donald J. 1956. AN ECOLOGICAL STUDY OF LOWER SAN GABRIEL RIVER, CALIFORNIA, WITH SPECIAL REFERENCE TO POLLUTION. Calif. Fish and Game, Vol. 42, No. 1, Jan., pp. 51-61.

An ecological study of Lower San Gabriel River was conducted in 1952. In the fall of that year, a section of the heavily polluted sampled area was rechannelized for flood control. The river was restudied in 1954 to determine the effect of the excavation on pollution conditions. Waters included were brackish and marine.

In 1952, no living animals were observed in the bottom though several were collected in the high tide horizon. In 1954, 12 species of typically estuarine invertebrates were collected on the bottom, the majority of which were found in the excavated section. Evidently they had migrated or drifted in as larvae. There was evidence of new deposits of pollutants forming in this area.

797. Pycha, Richard L. 1956. PROGRESS REPORT ON WHITE STURGEON STUDIES. Calif. Fish and Game, Vol. 42, No. 1, Jan., pp. 23-35.

After 35 years of complete closure, a sport fishery for sturgeon (Acipenser transmontanus and A. medirostris) was established in California in 1954. A life history study of the former was begun to evaluate the one-fish-per-day bag limit, 40-inch size limit, and no closed season regulations. A total of 1,003 sturgeon ranging in size from 31 to 94 inches was captured with trammel nets in San Pablo Bay, tagged, and released. Pectoral spine sections were collected from the fish tagged and from fish taken by anglers for age studies. The recapture of 45 fish while tagging gave a total population estimate of 11,154 fish in San Pablo Bay. In the first five months after tagging, only six tags were turned in by anglers and five by commercial fishermen. Only two fish were recaptured upstream in the Sacramento River. The frequency of anglers catches suggests a winter or spring upstream migration and summer downstream migration of large fish. Small fish appear to be nonmigratory.

The fin ray method of age determination appears to be valid. Fish from 0 to 30 years old were aged, with age groups VI and XVI comprising about half of all fish taken. Recruitment was very poor prior to 1936 and from 1940 to 1947. Another large group of young fish is just entering the fishery. Sturgeon attain a length of 40 inches in the eighth year, 50 inches in the 13th year, and 94 inches in the 30th year. Weight increases slowly with length up to 35 inches, increases rapidly between 35 and 45 inches, slackens somewhat between 50 and 60 inches, and increases rapidly beyond that length. Exploitation of sturgeon is still at a low level, but is increasing. Because of the great increase in weight between 40 and 50 inches and wide year-class fluctuations, a 50-inch size limit is recommended to provide a buffer stock of large fish for anglers and to insure maintenance of an adequate spawning stock. (A)

798. Gangmark, Harold A. and Robert D. Broad. 1956. FURTHER OBSERVATIONS ON STREAM SURVIVAL OF KING SALMON SPAWN. Calif. Fish and Game, Vol. 42, No. 1, Jan., pp. 37-49.

Because of the apparent correlation of king salmon egg mortality between the stages of fertilization and hatching in Mill Creek, California, with stream freshets in 1952-53, a controlled flow area was established for further investigation in 1953-54. The technique for conducting the experiment involved enclosing fertilized eggs with gravel in plastic screen sacks and burying them in the streambed. The sacks were removed at five different stages and various influences that may have affected survival were noted. In one experiment involving 50 such sacks early losses were noted in the first two periods, in each of which a freshet occurred. The mortality rate was comparatively light during the last two periods when stream flows remained stable.

Early mortalities during 1953-54 accompanied early freshets. In 1952-53 mortalities were at first small, while stream flows were stable, but later increased with the occurrence of the first

freshet, with complete loss following a subsequent flood. A second experiment in 1953-54 involved placing eggs in the main stream and planting a similar group in a controlled flow channel. Stream flows were moderate and survival rates were comparable in the creek and controlled flow area until January 17, 1954, when a freshet occurred. Results of this freshet on the main stream area were complete erosion of the streambed; loss of experimental cartridges and natural spawn from the riffle; and a change of the channel and a heavy deposit of silt on the banks. Eggs in the controlled flow area, however, suffered mortalities from silt deposition only. After the freshet, only areas in which the rate of flow was reduced by the stream dividing and subdividing produced eggs and alevins. (A)

799. Randall, John E. 1956. A NEW METHOD OF ATTACHING PETERSEN DISK TAGS WITH MONOFILAMENT NYLON. Calif. Fish and Game, Vol. 42, No. 1, Jan., pp. 63-67.

In the course of a life history study of the convict surgeon fish (Acanthurus triostegus sandircensis) in the Hawaiian Islands, several methods of marking and tagging were attempted. The most practical method developed involves $\frac{1}{2}$-inch diameter disks of laminated cellulose acetate, 0.036 inches thick at the center and 0.045 inches thick at the edge, and 0.035-inch monofilament nylon. To avoid time consuming knot tying and other disadvantages of knotted nylon, each end of the nylon is heated to form a 2 mm. knob. Tests indicate that heat reduces the tensile strength of the nylon from a rated 60-pound test to a 9 to 11-pound test; rapid cooling by immersion in water further reduced this by one-half. A tensile strength of 10 pounds, however, should be sufficient. The best flame producing device for such tagging was found to be a Ronson Windlite cigarette lighter.

800. Schumacher, R. E., C. H. Hamilton, and E. J. Longtin. 1956. BLOOD SEDIMENTATION RATES OF BROOK TROUT AS AFFECTED BY FURUNCULOSIS. Prog. Fish-Cult., Vol. 18, No. 4, Oct., pp. 147-148.

Blood sedimentation rates were recorded for 80 normal brook trout (Salvelinus fontinalis) and 80 brook trout known to be infected with furunculosis. One and one-half cc of heart blood was taken hypodermically from each trout, mixed with 0.2 cc of 6 percent sodium citrate, shaken, and placed in Westergren sedimentation pipettes. Sedimentation levels were recorded for 15, 30, 45, and 60 minutes after setup. For the normal group, the successive readings were 1.3, 2.0, 3.6, and 5.5 mm. The group of infected brook trout had successive readings of 3.7, 6.2, 9.3, and 14.8 mm. Results indicated a possible diagnostic technique to distinguish diseased trout from normal trout. (A)

801. Buss, K. W. and J. E. Wright, Jr. 1956. RESULTS OF SPECIES HYBRIDIZATION WITHIN THE FAMILY SALMONIDAE. Prog. Fish-Cult., Vol. 18, No. 4, Oct., pp. 149-158.

The viability of eggs and fry resulting from the reciprocal crosses, backcrosses, and, in some cases, the recurrent backcrosses among the various genera and species of trout were recorded. Species used in these experiments were the eastern brook trout (Salvelinus fontinalis), lake trout (Salvelinus namaycush), brown trout (Salmo trutta), rainbow trout (Salmo gairdneri), and landlocked salmon (Salmo salar sebago). Hatchability and sac-fry survival were found to be related to certain factors characteristic of the parent species, such as compatibility of chromosome number and morphology, differences in length of the incubation periods of the eggs of the parent species, and egg size of the maternal species. It was concluded that lake trout should be in the genus Salvelinus rather than Cristivomer because of their ability to hybridize readily with brook trout and produce fertile progeny, and because of the identical chromosome numbers of the two species. Blue-sac disease was indicated to be a morphogenetic disturbance rather than a pathogenic disturbance, as incidence of blue-sac disease was far more prevalent in hybrid lots than in control groups. Some evidence of parthenogenesis was found in trout eggs. (A)

802. Phillips, Arthur M., Jr. and Donald R. Brockway. 1956. THE NUTRITION OF TROUT II. Protein and Carbohydrate. Prog. Fish-Cult., Vol. 18, No. 4, Oct., pp. 159-164.

A general review of the functions of protein and carbohydrate in the animal body is followed by a review of the requirement of trout for these substances. The protein requirements, as commonly accepted, is stated as 28 percent of the diet. The factors affecting the efficient utilization of protein by trout are discussed. The maximum level of dietary carbohydrate for trout is noted as 9 to 12 percent, based upon digestibility. Excessive carbohydrate in the diet results in a physiological upset. A selected bibliography is given for both protein and carbohydrate. (A)

803. Lindroth, Arne. 1956. SALMON STRIPPER, EGG COUNTER, AND INCUBATOR. The Prog. Fish-Cult., Vol. 18, No. 4, Oct., pp. 165-170.

Female and male stripping methods are described, the former being aided by a double-walled rubber sack in which water pressure replaces usual hand pressure and the latter involving the collection of milt upon emission by a jet suction pump. Details of an egg counter utilizing a plastic counter plate with known number of holes are covered. The plastic-tray incubator, each tray measuring 54 by 30 by 1.5 centimeters, requires very little room and less than 1 liter per second of water per 1,000,000 eggs. One meter along a wall will accomodate three stacks of 70 trays each with 2400 eggs per tray. Though eggs are easily picked, actual hatching is not conveniently carried out in the shallow trays. Details of the incubator are given.

804. MacMartin, James M. 1956. NONBREAKABLE SAMPLE BOTTLES FOR WINTER OXYGEN

DETERMINATIONS. Prog. Fish-Cult., Vol. 18, No. 4, Oct., p. 170.

An 8-ounce polyethylene (Nalgene) bottle fitted with an Escher stopper, an elongated rubber stopper used in bacteriological work, proved entirely satisfactory. Due to bottle size, half the normal aliquot is used for titration and the value is doubled to obtain oxygen content in parts per million.

805. Moss, D. D. and J. M. Hester. 1956. FARM-POND INVESTIGATIONS IN ALABAMA. Prog. Fish-Cult., Vol. 18, No. 4, Oct., pp. 171-177.

During the fall and winter of 1952 and spring of 1953, a total of 106 farm ponds, their sizes ranging from 0.5 to 25 acres, were stocked with bluegill (Lepomis macrochirus), shellcracker (L. microlophus), and largemouth bass (Micropterus salmoides). Efforts were made to stock all ponds with a combination of 1,000 bluegill and shellcracker fingerlings and 100, 125, or 150 bass fingerlings per acre. Fish population studies were conducted in the ponds during the summers of 1954 and 1955 to determine which of the bass stocking rates tested resulted in the greatest number of successful ponds and to determine as closely as possible the major factors which resulted in unsuccessful ponds. A comparison of balance conditions of the ponds did not indicate that any one of the bass stocking rates used was superior to the others. The principal factors that resulted in or contributed to pond failures appeared to be the presence of wild fish in the ponds before hatchery fish were stocked, the migration of wild species into ponds where precautions were taken to eliminate wild fish before stocking, and the removal of bass before they had spawned for the first time. (A)

806. Leitritz, Earl and Robert Macklin. 1956. FISH-ESCAWEIGHER. The Prog. Fish-Cult., Vol. 18, No. 4, Oct., pp. 178-180.

This tank-truck loading device is patterned after a conventional flat-belt conveyor. Important differences are the use of a rubber cleated belt, construction primarily of aluminum, and two pneumatic-tired wheels for portability around the hatchery. No fish remains on the belt more than 10 seconds, and all water escapes before the fish reach the top and drop into the tank truck. As no water is added at the time of loading the fish, displacement is used to weigh the fish. Where three men took 1.5 hours to load 2,000 pounds of fish, two men can now do the job in 15 minutes.

807. Loftus, K. H. 1956. EQUIPMENT FOR DROPPING FISH. The Prog. Fish-Cult., Vol. 18, No. 4, Oct., pp. 181-184.

Details of tanks, trays, release chute, and oxygen and water systems as designed for use in Beaver aircraft are described. Total weight of all equipment for two tanks, one plane load, excluding a tank operator, is 593.75 pounds. Each tank can carry 4,500 three- to five-inch yearling trout.

808. Webster, Dwight A. 1956. RATE OF FIN-CLIPPING. The Prog. Fish-Cult., Vol. 18, No. 4, Oct., pp. 185-187.

The average hourly rate of marking 3- to 3.75-inch fingerling lake trout varied from 656 for removal of the right or left ventral fins to 941 for the adipose fin. The average rate of marking 5- to 6-inch yearling lake trout by removing the adipose and one other fin ranged from 338 per hour for the right pectoral and adipose to 540 per hour for the left pectoral and adipose. Average marking rates for other species were rainbow trout, 5- to 6-inch, pectoral, 560; rainbow, 5- to 6-inch, pectoral, 626; rainbow, 2- to 3-inch, ventral, 506; rainbow, 2- to 3-inch, pectoral, 333; brook trout, 5- to 6-inch, adipose, 748; smallmouth bass, 2- to 3-inch, pectoral, 580; smallmouth bass, 2- to 3-inch, pectoral, 610.

Use of an anesthetic which in itself is time consuming has been found most helpful for fish less than 3 inches or over 9 inches in length. Marking techniques developed in marking 700,000 fish in the past 15 years at Cornell University are described.

809. Sullivan, Carl R. 1956. THE IMPORTANCE OF SIZE GROUPING IN POPULATION ESTIMATES EMPLOYING ELECTRIC SHOCKERS. Prog. Fish-Cult., Vol. 18, No. 4, Oct., pp. 188-190.

The selectivity of electric shockers in taking larger fish was studied in Potomac River drainage streams of West Virginia. In mark-and-recapture population estimates, the percentage of recapture of large fish was consistently higher than that for small fish. In order that this error might be partially corrected, fish species were divided into two or more size groups, i.e., small, medium, and large. Each size group was treated separately in mark-and-recover estimates. The data showed that some species were collected much more easily than others. (A)

810. Lennon, Robert E. and Phillip S. Parker. 1956. A COLLAPSIBLE LIVE-CAR FOR FIELD USE. The Prog. Fish-Cult., Vol. 18, No. 4, Oct., pp. 191-192.

Constructed of readily available "do-it-yourself" aluminum, this 18-inch by 18-inch by 12-inch deep live cart cost approximately $16 and proved to be durable. Its collapsible design permits the six sides to be bundled for storage or transporting.

811. Dence, Wilford A. 1956. MIGRATION BEHAVIOR OF A DWARF SUCKER WITH AN INJURED BRAIN. The Prog. Fish-Cult., Vol. 18, No. 2, April, pp. 95-96.

A $5\frac{1}{2}$-inch dwarf sucker, Catostomus commersonni utawana, was found in vigorous condition on the breeding grounds 2 weeks after others had spawned and returned to the lake. The injury, involving removal of both olfactory nerves as well as all of the left and part of the right olfactory lobes, seems to be the logical explanation of this abnormal migration behavior. This substantiates the theory of Hasler and Wisby that sense of smell

plays an important role in directing fishes during migration.

812. Anonymous. 1956. TROUT AND GRAYLING POPULATIONS IN GREBE LAKE. The Prog. Fish-Cult., Vol. 18, No. 2, April, p. 96.

Analysis of data for the past 3 years of study on this lake, located in Yellowstone National Park, indicates that trout and grayling populations are in a healthy state of equilibrium. No evidence of serious competition between these species is apparent. Though the present management is sound, a larger harvest of grayling could be taken without causing harm. These conclusions are based on grayling spawning escapements, grayling fingerling abundance estimates, and creel census data and population estimates for both species.

813. Morton, K. E. 1955. MULTI-PURPOSE ELEVATED HOLDING TANKS FOR YEARLING TROUT LIBERATIONS. The Prog. Fish-Cult., Vol. 17, No. 2, April, pp. 82-84.

These tanks, placed on a platform sufficiently high to permit gravity loading of trucks through a 6-inch metal flex tubing, increase efficiency of liberations. Tanks are filled at any convenient time of the day, trucks can be loaded at any time with a minimum effort (780 pounds in 5 minutes), and employee overtime has been reduced as a loading crew need not be on hand when a truck is loaded.

814. Meigs, Robert C. and Cliff Millenbach. 1955. UTILIZATION OF HATCHERY FISH. The Prog. Fish-Cult., Vol. 17, No. 2, April, pp. 87-88.

A study of returns from fingerling trout stocked in chemically rehabilitated lakes in Washington revealed that larger returns from waters in the eastern part of the State were due to the differential in size of the fish stocked. Plantings in eastern Washington were composed of fish averaging 200 to 500 per pound while those made in western Washington averaged 1,000 to 1,400 per pound. Eggs from fall-spawning rainbow trout are now procured for the western hatcheries with their colder water supplies to enable them to counteract this size difference at stocking time.

815. Greene, A. F. C. 1955. WILL STUNTED BROOK TROUT GROW? The Prog. Fish-Cult., Vol. 17, No. 2, April, p. 91.

Stunted brook trout taken from two streams were marked and planted in two reservoirs in November 1953. All fish taken the following season showed an average increase of 3.53 inches in length and of 6.98 ounces in weight. The greatest increase in weight was 12.00 ounces and the least 3.00 ounces. The greatest increase in length was 7.63 inches, made by a 2-year-old fish; the least was 2.13 inches. Three-year-old fish increased 3.51 inches in length while 4-year-old fish increased only 2.81 inches in length. Reservoir waters were much more alkaline than stream waters, a factor considered most important to the growth exhibited by the transplanted trout. Apparently the length of time spent in the stunted population has some effect on the potential growth that may be expected from fish so transplanted.

816. Burdick, Milton E. and Edwin L. Cooper. 1956. GROWTH RATE, SURVIVAL, AND HARVEST OF FINGERLING RAINBOW TROUT PLANTED IN WEBER LAKE, WISCONSIN. J. Wildlife Mgt., Vol. 20, No. 3, July, pp. 233-239.

Weber Lake, approximately 40 acres in size with a maximum depth of 47 feet, was treated with rotenone in 1942 to eliminate a mixed population of warm—water fishes which were growing slowly and furnishing poor fishing. Rainbow trout were first introduced in 1945 and annual plantings have been made since that date. Fishing pressure has been heavy, averaging about 150 hours per acre per year. The annual production of trout has averaged 7.4 pounds per acre and has amounted to approximately 4 pounds of trout caught for each pound of small trout planted in the lake.

Few of the trout planted lived to be 5 years old, with fish in their second and third years of life dominating the catch. The largest trout caught in 6 years was 25 inches in length and weighed over 6 pounds. During any one year, the growth rate was most rapid during the period from April to October. Some growth, however, occurred during the remaining winter period.

Larval forms of caddisflies, burrowing mayflies and midges were consistently important items of the trout diet. Minnows and small freshwater crustaceans were also taken in abundance in some years. Direct predation of small trout was observed in only one of the 1,314 stomachs analyzed. The presence of minnows in trout lakes are generally considered to be detrimental to trout production, because of direct competition for food. Trout of all sizes readily feed on plankton crustaceans and small invertebrates; minnows do not seem to be necessary for continued good growth of the trout. (A)

817. Moyle, John B. 1956. RELATIONSHIPS BETWEEN THE CHEMISTRY OF MINNESOTA SURFACE WATERS AND WILDLIFE MANAGEMENT. J. Wildlife Mgt., Vol. 20, No. 3, July, pp. 303-320.

Relationships between the chemistry of Minnesota surface waters and biological, geological and climatological patterns are considered. Climate and geology result in a gradual increase in the mineral content of waters across Minnesota from northeast to southwest and allow delineation of approximate lines of equal concentration for carbonates, sulphates, chlorides, total phosphorus and total nitrogen that run in a general northwest-southeast direction. Distribution of fish associations and upland and aquatic vegetation shows similar patterns. Water chemistry and factors associated with it are related to both size and structure of fish populations. It is suggested that within the ranges considered the general relationship between weight of the standing fish crop of mixed fish populations and carbonates and salinity is in the nature of a parabolic curve while the re-

lationship for total phosphorus and total nitrogen approaches a straight line. In order of increasing fertility of waters fish populations are characterized by lake trout, pikeperch, bass, and panfish and rough fish and it is likely that each species has an optimum for water fertility and factors associated with it. Other aspects of the chemistry of fresh waters are considered in the light of the 1,546 analyses and the more recent literature. (A)

818. Cleary, Robert E. 1956. OBSERVATIONS ON FACTORS AFFECTING SMALLMOUTH BASS PRODUCTION IN IOWA. J. Wildlife Mgt., Vol. 20, No. 4, Oct., pp. 353-359.

Annual surveys on 17 Iowa smallmouth bass streams during 1949-1954 indicated that certain factors such as precipitation, temperature, turbidity and stream morphology were among the most important physical factors affecting smallmouth production in these streams. Pre-nesting precipitation in the watershed had no apparent effect on the annual smallmouth nesting intensity. However, during years in which the average precipitation in the watershed was less than 7 inches for a 45-day post-nesting period, hatching and survival were considered good. Nest counts were thought to be simply an index to the quality of the nesting habitat and could not be used as an index to the strength of the adult or spawning bass population. There was no apparent correlation between nesting intensity and either the fingerlings produced or the angling success on a given stream. Prolonged periods of low temperature during the spawning season also works a disadvantage to successful reproduction. It was calculated that between 300 and 375 fingerling smallmouth bass were an average annual production for these streams. (A)

819. Foye, Robert E. 1956. RECLAMATION OF POTENTIAL TROUT PONDS IN MAINE. J. Wildlife Mgt., Vol. 20, No. 4, Oct., pp. 389-398.

Chemical treatment with rotenone compounds resulted in the complete removal of undesirable species in 5 of 7 ponds reclaimed in 1951. Reclamation techniques are discussed. The results of a 3-year study at these ponds are presented. Creel returns following the stocking of brook trout (Salvelinus fontinalis) and brown trout (Salmo trutta) exhibited wide differences between individual waters. A low daily bag limit on heavily fished brook trout ponds was found desirable. Conversely the need for a low daily bag limit on brown trout waters could not be substantiated. Fly fishermen success equaled that of bait fishermen. The "fly fishing" regulation at one pond did not improve the quality of fishing during the 3-year period. Ice fishermen accounted for a high percentage of the total catch of brook trout from one pond while catches of brown trout by ice fishermen were insignificant. An introduction of sea-run alewives (Pomolobus pseudoharengus) provided excellent forage for brown trout and resulted in a high rate of survival of fingerling brown trout. Brook trout spawned successfully on the shores of three ponds. Their contribution to the fisheries of these waters is discussed. (A)

820. Moyle, John B. and Jerome H. Kuehn. 1956. WALLEYES VERSUS PANFISH FISHING. The Conservation Volunteer, Minn. Dept. of Conservation, Vol. 19, No. 111, May-June, pp. 14-18.

Fishermen took an estimated 349,517 fish weighing 175,122 pounds from 14 census lakes during the fishing year December 1, 1954 to November 30, 1955. Seven of these lakes, which are being managed for yellow walleye, have a total area of 7,549 acres. They produced 111,989 fish weighing 74,166 pounds. In contrast, the other 7 lakes, managed for bass-panfish, total 4,304 acres and produced 237,528 fish weighing 100,956 pounds. Total catch in all 14 lakes ranged from 15.2 to 42.1 pounds per acre, averaging 23.4 pounds per acre.

With one exception the total catch from walleye lakes ranged from 1.7 to 8.1 pounds per acre per year with an average of 5.8 pounds per acre. Catch of walleyes alone from the walleye lakes ranged from 0.4 to 3.2 with an average of 2.6 pounds per acre. It appears, therefore, that in terms of yield the bass-panfish waters are about 4 times as productive as walleye waters. Similarly, acre for acre, bass-panfish waters supply more fishing trips than walleye lakes the average figures being 21.3 and 7.8 fishing trips per acre per year. The percentage composition of the catch in pounds of fish from the bass-panfish lakes was sunfish 21.9; crappies 29.1; northern pike 26.4; largemouth bass 8.3; walleye, 4.5; and other species 9.8 percent. The catch from walleye lakes, as might be expected was largely of walleyes and northern pike, the percentage compositions by weight being walleyes 26.1; northern pike 27.3; sunfish 20.5; crappies 3.6; largemouth bass 0.8 and other species 21.8 percent.

For the seven bass-panfish lakes a downward trend noted in 1954 for northern pike catches continued in 1955 and associated with this was an increase in average size of northern pike taken by all fishing methods. This suggests that spawning conditions have been below par for this species in recent years and the older fish made up a larger proportion of the catch. The 2- and 3-year-old northern pike which normally supply much of the fishing were in short supply.

821. Beak, T. W. 1955. SCOTLAND'S SALMON FISHERIES. The Atlantic Salmon J., No. 4, Dec., pp. 12-14.

The most recent major development in fishways has been the Borland fish pass. This Scottish invention replaces the expensive 30 to 50 pools of the traditional fishway by two pools and an intercommunicating pipe together with automatically operated sluice gates. Although a Scottish invention, the first Borland pass was constructed on the River Liffy in Ireland. It proved successful in getting salmon over the dam and has now been incorporated in a number of Scottish dams. It will likely be the standard fishway in Scottish hydroelectric schemes as not only is it much more economical to construct than the traditional passes, but lends itself more readily to big fluctuations of

reservoir level.

822. John, Kenneth R. 1956. ONSET OF SPAWNING ACTIVITIES OF THE SHALLOW WATER CISCO, LEUCICHTHYS ARTEDI (LeSueur), IN LAKE MENDOTA, WISCONSIN, RELATIVE TO WATER TEMPERATURES. Copeia, No. 2, May 29, pp. 116-118.

During recent years, observations at Lake Mendota indicate that cisco generally arrive on the spawning grounds when the temperature drops to 5-6° C, but that several days pass before egg-deposition begins. The extent of the delay is apparently determined by the course of temperatures. The literature on white fishes in general indicates that initiation of spawning activities is strongly linked with specific values of temperature, all of which are relatively low, and may differ from one region to another.

In Lake Mendota and Lake Constance and presumably in other lakes, egg-laying is initiated by a specific value of temperature provided this value obtains early in the season. If the arrival of this temperature is delayed, spawning is accordingly delayed, but not for an indefinite period. Rather, it occurs at a temperature higher than that which was thought to merit the term "critical". Other stimuli that may act in conjunction with temperature in initiating the spawning activities of the cisco are unknown.

Judging from studies made on other whitefishes, the tendency for spawning to take place at a later date on those years when higher temperatures prevail suggests that it is an adaptation of survival value. The mortality rate for cisco embryos in the early stages of development is undoubtedly proportional to the temperature, as it is for C. clupeaformis and for C. wartmanni. Hence, the longer the females retain their eggs during the autumnal thermal recession, the greater is the chance that the eggs will be deposited at a more favorable temperature, e. g., near the so-called threshold value. Price also stated that the eggs of C. clupeaformis, during the early stages of cleavage, are extremely sensitive to fluctuations in temperature. Spawning after the lake has become isothermal at some value below 4° C, subjects the eggs to less chance of drastic thermal changes as the eggs lie on the bottom and water is at its maximum density at 4° C.

In contrast to the foregoing hypothesis, the delay in spawning accompanying late autumns may lead to a lower survival rate of the eggs. (The time of ovulation in the cisco relative to environmental temperatures is unknown). There may be a short limit to the length of time that the eggs remain viable subsequent to ovulation, though they be carried in the body cavity of the female. The later spawning seasons concurrent with warm autumns appear superficially to be an inherent compromise designed to lessen the mortalities of eggs likely to occur either through a loss of viability before fertilization, or by temperature effects after fertilization.

823. Shomura, Richard S. and Garth I. Murphy. 1955. LONGLINE FISHING FOR DEEP-SWIMMING TUNAS IN THE CENTRAL PACIFIC, 1953. Spec. Sci. Rep. No. 157, Sept., 70 pgs.

The Pacific Oceanic Fishery Investigations conducted six longline cruises in the equatorial region of the Pacific between 140° W. longitude during 1953. The catches experienced during the several crossings of the equatorial current system were consistent with earlier findings. Yellowfin were found most abundant in the region near the Equator which is enriched by upwelling. Bigeye were most abundant south of the Equator. The results suggest that the longitude of best catch shifted during the year, and that east-west movements recur from year to year.

Catches around Christmas Island were higher than in the open ocean, at least in part because small "surface yellowfin" were taken in addition to the large deep-swimming yellowfin. During 1953 more small yellowfin were taken near islands than offshore. The size of oceanic yellowfin was uniform from 140° W. to 160° W. longitude, but specimens from 170° W. were small. The size of the yellowfin taken at 150° - 155° W. longitude did not change materially throughout the year. Males predominated among the larger yellowfin, bigeye, and albacore. (A)

824. Schoffman, Robert J. 1956. AGE AND RATE OF GROWTH OF THE YELLOW BASS IN REELFOOT LAKE, TENNESSEE, FOR 1939 AND 1955. J. of the Tenn. Acad. of Sci., Vol. 31, No. 1, Jan., pp. 20-25.

The 1955 Tennessee Legislature abolished commercial fishing in Reelfoot Lake for game fish, with the exception of yellow bass. Prior to that time, commercial fishing for all game fish was legal. This study will serve as a base for determining what effect if any the limiting of commercial fishing to yellow bass will have on this species. Length and weight data are presented for 129 yellow bass commercially caught with hoop nets and wire set-nets in 1939 and 518 commercially caught with trot lines in 1955. No fish were over 6 years old, longer than 12 inches, or heavier than 15 ounces. Increase in length and weight was slow after the second year of life.

Age Group	No. of Fish	Average Length Inches	Average Weight Ounces
		1939	
2	44	7.775	4.14
3	45	8.688	5.86
4	28	9.988	9.15
5	12	11.641	14.10
		1955	
2	127	7.720	3.58
3	167	8.687	5.25
4	204	9.467	7.17
5	20	10.712	10.40

825. Trama, Francesco B. 1955. THE ACUTE TOXICITY OF PHENOL TO THE COMMON BLUEGILL. Notulae Naturae of the Acad. of Nat. Sci. of Philadelphia, No. 269, March 25, 10 pgs.

Ten bluegill were tested at each concentration of phenol. All tests were run in duplicate and at a constant temperature of 20° ± 1° C. Due to the instability of pure phenol in a water solution and the failure of continuous renewal of test solutions at a rate as high as 10 gallons in 24 hours to reduce the rate of loss of phenol from a 5-gallon jar containing aerated water and 10 fish, the test fish were transferred at the end of every 24 hours to a bottle of fresh test solution. Phenol concentrations were kept thereby within a limit of ± 2 ppm. over the 96-hour test period. Controls were run concurrently at a rate of 10 control fish per 20 test fish under exactly the same conditions.

Phenol produced a definite toxic effect. The concentration at which 50 percent of the test organisms survive (TLm) is estimated to be 19.3 ± 2 ppm. The 4-hour TLm is estimated to be 20.5 ± 2 ppm.; the 96-hour TLm is 19.3 ± 2 ppm. The closeness of these two values indicates that fish surviving a 48-hour exposure tended to survive at least an additional 48 hours. Fish reacted immediately and violently to phenol concentrations of 15.0 ppm. and above, but this reaction was not observed at a concentration of 10.0 ppm. Those surviving 24 hours appeared quiescent, but were extremely sensitive to sudden light and vibration.

826. Srinivasan, R., P. I. Chacko and A. P. Valsan. 1955. A PRELIMINARY NOTE ON THE UTILITY OF SODIUM PHOSPHATE IN THE TRANSPORT OF FINGERLINGS OF INDIAN CARPS. Ind. J. of Fish., Vol. 2, No. 1, April, pp. 77-83.

Use of disodium phosphate to counteract accumulation of carbon dioxide in the transport of Indian carp fingerlings was studied. The addition of the phosphate did not decrease the mortality of fingerlings during their transport in ordinary open tin carriers as the main problem is probably one of replenishment of oxygen rather than removal of carbon dioxide. Addition of the salt at the rate of 1.5 grams per liter of water in closed oxygen containers, however, reduced mortality significantly. Addition of greater amounts did not result in any further reduction in mortality, in fact, mortality was higher in tanks with 30 grams per liter.

827. Prosser, C. Ladd. 1955. PHYSIOLOGICAL VARIATION IN ANIMALS. Biol. Rev. of the Cambridge Philosophical Soc., Vol. 30, No. 3, Aug., pp. 229-262.

Numerous examples are cited of physiological characters which, like morphological characters, vary genotypically, ontogenetically or phenotypically. Physiological variation is useful in describing interspecific relations, intraspecific variation, and the limits of ecological range. It permits the establishment of populations at environmental limits and thus predisposes a race for genetic fixation of a character. Such variation is primary in providing one mechanism of reproductive isolation. Secondary physiological variation functions in habitat selection, particularly after reproductive isolation. Criteria for physiological variation are given by measurement of internal state in relation to environmental stress.

Examples of physiological variation, in osmotic adaptation and in temperature tolerance or selection, in different populations of the same species are given. Variation with respect to ionic balance, oxygen, light, food, reproductive behavior and tolerance of type of substratum, stream, and wind velocity are covered. Need for physiological study of intraspecific variation according to history and distribution of natural populations is stressed.

828. Bullock, Theodore Holmes. 1955. COMPENSATION FOR TEMPERATURE IN THE METABOLISM AND ACTIVITY OF POIKILOTHERMS. Biol. Rev. of the Cambridge Philosophical Soc., Vol. 30, No. 3, Aug., pp. 311-342.

This article calls attention to evidence, old and new, supporting the thesis that many cold-blooded animals are, within limits, relatively independent of temperature in nature. These species tend to maintain a certain level of metabolism and other characters measured as rates, compensating for different temperatures by homoeostatic mechanisms of various kinds. Illustrative cases are assembled, and a number of exceptions are listed which show that the ability to compensate is far from universal. The mechanisms and properties of compensation are discussed.

Some species are at first hyper-sensitive to temperature change, settling down to a steady rate after some hours, others are initially unresponsive. Neglect of this short-term time factor vitiates many comparisons between rate-temperature curves taken during dissimilar phases of response to changes. The wide distribution and demonstrated natural occurence of acclimation and related rate compensations for temperature indicate a large-scale role in ecology and evolution.

829. Larsen, Knud. 1954. ELECTROFISHING OF SEA TROUT FOR STRIPPING. Meddelelser Fra Danmarks Fiskeri-Og Havundersogelser, Ny Serie, Bind I, Nr. 6., pp. 1-12.

Experiments on collecting mature sea trout and salmon with D. C. equipment for stripping showed that neither fish nor the eggs were injured. It was found that large deep streams can perhaps be fished more effectively with A. C. equipment but large fish are often seriously injured by this means.

830. Anonymous. 1956. AQUATIC LIFE WATER QUALITY CRITERIA. (Second Progress Report of the Aquatic Life Advisory Committee of the Ohio River Valley Water Sanitation Commission). J. of Sewage and Industr. Wastes, Vol. 28, No. 5, May, pp. 678-690.

In this second progress report the committee states its findings and conclusions with regard to temperature, dissolved solids, settleable solids, chloride ion, fluoride ion, and color. Supplementary data and a discussion on the dissolved-oxygen

requirements presented in the first progress report are provided.

The following recommendations are made:
(1) Temperature Requirements. Waste discharges to be so controlled that the temperature of the receiving water shall not be raised above 34° C. (93° F) at any place at any time, shall not be raised above 23° C. (73° F.) at any place or at any time during the months of December through April, and shall not be raised in streams suitable for trout propagation.
(2) Dissolved Solids Requirements. Bioassay be used to determine the degree of dilution essential for the safe disposal of brines and other complex wastes which are high in dissolved solids. Local species of fishes and dilution water from the receiving water course should be used in the assays.
(3) Settleable Solids Requirements. As the effects of settleable solids on fish food production, fish spawning, and phytoplankton production are not known precisely, organic wastes not be added to a stream in such quantity that they alone or in combination with inorganic materials form sludge beds or changes the physical nature of the bottom.
(4) Chloride Ion Requirements. As an expression of the chloride ion concentration has, in itself, no practical significance since the cations are the potentially toxic agents, bioassay be used for the evaluation of effects on aquatic life of brines and other industrial wastes containing chlorides.
(5) Fluoride Requirements. As the enforcement of drinking water standards will protect fish populations, as fluoride effects are cumulative in domestic animals, and as there is no data concerning the chronic effects of fluorides on aquatic organisms, fluoride-ion concentration in any stream not be permitted to reach levels above those found safe for human consumption.
(6) Color Requirements. The most favorable conditions for the growth of higher aquatic plants require that water transparency permit at least 25 percent of total solar radiation reaching the plants. While this is seldom attained in many of the larger streams even when unpolluted, it is desirable to restrict the addition of any substances to natural waters that would reduce aquatic vegetation productivity through lessening of light penetration.

831. King, John E. 1954. THREE YEARS OF PARTIAL FISH POPULATION REMOVAL AT LAKE HIWASSEE, OKLAHOMA. Reprint from Proc. of the Okla. Acad. of Sci., Vol. 35, pp. 21-24.

Rotenone applied to a 20-acre area of this 154-acre lake in 1951, to a 30-acre area in 1952, and to the entire shoreline in 1953 and 1954 failed to fully accomplish the desired increase in angling success and fish growth, though sufficient rotenone has been used in the three operations to theoretically eliminate the entire population if applied at one time. Largemouth bass, redear sunfish, bluegill, and white crappie showed an increase in growth since the 1953 application, whereas channel catfish showed little improvement being retarded by an extremely abundant and slow growing 1950 year class. Failure might be attributed to increased turbidity, inherent low productivity, and inability to remove an adequate proportion of overpopulated species without seriously reducing bass and forage populations.

832. Morrow, James E. 1955. A THRESHER SHARK FROM LONG ISLAND SOUND. Postilla (Yale Peabody Museum of Natural History) No. 24, Dec.

A juvenile female weighing 43 pounds and measuring 957 mm. from tip of snout to anterior edge of the pre-caudal notch and 1,982 mm. overall was foul hooked by a sportsman in Long Island Sound approximately 5 to 6 miles due south of Niantic, Connecticut. This seems to be the first definite record of this species for Long Island Sound.

833. Gunning, Gerald E. and William M. Lewis. 1956. AGE AND GROWTH OF TWO IMPORTANT BAIT SPECIES IN A COLD-WATER STREAM IN SOUTHERN ILLINOIS. The Amer. Midland Nat., Vol. 55, No. 1, Jan., pp. 118-120.

Ages 0, I, II, and III were represented in the stoneroller sample, age-group II being the most abundant representing 65 percent of the sample. Stoneroller reached usable bait size, 3 inches total length, at the end of the second summer of growth; their life span is probably three years. Their body length-scale radius relationship is described by a straight line with an intercept of 13 millimeters on the length axis and with a slope of 6.74.

Ages 0, I, II, III, and IV were represented in the creek chub sample, age-groups I and II being the most abundant. They reached a usable bait length, 3 inches, during their second summer of growth; their life span is probably short. The body length-scale radius relationship is described by a straight line with an intercept of 12 mm. on the length axis and with a slope of 3.36.

834. Mizelle, John D., Paul S. Stokely, Benjamin J. Jaskoski, Aaron P. Seamster, and Lawrence H. Monaco. 1956. NORTH AMERICAN FRESHWATER TETRAONCHINAE. The Amer. Midland Nat., Vol. 55, No. 1, Jan., pp. 162-179.

Four North American genera, two exotic genera, and one new genera are included. A "Host and Infecting Species" section enables an investigator to know the possibilities regarding identity after the host species has been identified. Twelve families of fishes including most of the common species are included in this section.

835. Bary, B. McK. 1956. THE EFFECT OF ELECTRIC FIELDS ON MARINE FISHES. Mar. Res. Rep. No. 1, New Zealand Defence Scientific Corps and Natl. Inst. of Oceanography. 33 pgs.

Marine fish have been subjected to uniform electric fields of 50 c/s. a.c., d.c. and pulsed d.c. in experimental conditions and comparisons of the effectiveness of these currents in producing three reactions, the minimum response, electrotaxis, and electronarcosis, have been made. Most of the experiments have been made with two groups

of mullet, Mugil auratus, one the Standard Fish, 18.5 to 20.6 cm. long, was used to determine the relationships between pulse duration, frequency of pulsing, voltage gradient and power required to induce electrotaxis and electronarcosis, and the effect of temperature on the requirements for narcosis with a.c. and d.c.; the second, or Group 2 Fish, 8.6 to 30.2 cm. long was used to find how the voltage required to produce the several reactions depended on the length of the fish and how it varied with fatigue and duration of time in captivity.

Experiments were carried out to find whether the voltage gradient of a.c. and d.c. required to induce the minimum response and electronarcosis varied between species. The evidence suggests that there is little if any difference between bass (Morone labrox), flounder (Platichthys flesus), and mullet (Mugil auratus).

In a d.c. field, the voltage required to elicit the minimum response when the head is pointing toward the anode is double the voltage required when the head points towards the cathode. The gradient required to produce electronarcosis in free-swimming fish is nearer what would be needed with d.c. —than with d.c. +. Alternating current (r.m.s. values) induces the minimum response at approximately one-half the voltage gradient needed for d.c. —and one-quarter of that for d.c. +.; for electronarcosis rather less than half the d.c. gradient is required. The ratios of the voltage gradients (and powers) necessary for inducing the minimum response and electronarcosis are approximately the same with either a.c. or d.c. Electrotaxis values with d.c. are intermediate between those for the minimum response and electronarcosis. The voltage gradients of a.c or d.c. needed to induce electronarcosis appear not to depend on the temperature, but higher gradients are needed to elicit the minimum response in a fatigued fish than in a rested or fresh fish.

Requirements for electrotaxis and electronarcosis induced with pulsed d.c. conform to a similar pattern. For a given pulse duration, there is an optimum frequency of pulsing. At higher frequencies, the voltage gradient required does not increase, but the power increases proportionally with the frequency; at frequencies less than the optimum, both gradient and power must be increased to obtain the desired effect As the pulse duration is lengthened, lower voltage gradients and frequencies are required to elicit a given response. The power needed varies with these factors, and in general it increases with pulse duration, although there is an indication that the power requirement for inducing electrotaxis is least at the pulse duration of 500 μs.

An increase in the length of fish demands an increase in the potential difference between nose and tail to induce any of the three reactions with the three types of electric field used; the increase of potential required is less than directly proportional to the increase in length (but becomes so if the threshold voltage is subtracted); hence long fish require a higher potential over their length, but a lower voltage gradient, than short fish. Empirical formulae have been evolved and are presented relating the voltage gradient and pulse duration required to electronarcotize or induce electrotaxis in fish of given length at the optimum frequency. The requirements for inducing electronarcosis with pulsed d.c. appear not to be affected by the time the fish is held in captivity, provided that it is healthy. Possible physiological reasons for the responses to electric fields are discussed.

836. Hasler, Arthur D. 1956. INFLUENCE OF ENVIRONMENTAL REFERENCE POINTS ON LEARNED ORIENTATION IN FISH (Phoxinus). Reprint from Zeitschrift fur vergleichende Physiologie, Bd. 38, S. 303-310.

Fish were trained to find food at the "north" position in a circular tank. The starting cue was the burning of a light 45° from north. When the tank was rotated 180° they sougth food in the south position. Elimination tests proved the orientation marks to be minute marks on the wall and floor of the tank and not the "sun".

The unusual ability of a fish to thus appraise his immediate environment and to use inconspicuous landmarks for orientation aid in explaining the homing ability of lake and shore fishes.

In two other units, each different, an artificial sun in the artificial sky was used as an orientation point by the fish only after moving all other marks continually during training. Long periods of frequent training were necessary; nevertheless, because these fish did eventually associate a 90° angle of the "sun" to a feeding position suggests the need for exploring further the fish's use of the sun in orientation. (A)

837. Eschmeyer, Paul H. 1956. THE EARLY LIFE HISTORY OF THE LAKE TROUT IN LAKE SUPERIOR. Misc. Pub. No. 10, Mich. Dept. of Conservation, Inst. for Fish. Res., Oct., 31 pgs.

Young-of-the-year, yearling, and 2-year-old lake trout were collected in bottom trawls by the U. S. Fish and Wildlife Service research vessel Cisco in Lake Superior in 1952 and 1953. Trawl collections of 2-year-old trout were supplemented by catches in gangs of experimental nylon gill nets of graded mesh.

Young-of-the-year lake trout were collected at eight stations in southern Lake Superior from the Apostle Islands, Wisconsin, eastward to Grand Marais, Michigan. Most were caught off Laughing Fish Point about 20 miles east of Marquette. Collections in June, July, and August were principally from depths less than 20 fathoms. After a severe storm in mid-September, first-summer lake trout were distributed over a wide range of depths. In October most were caught in water more than 20 fathoms deep. Water temperatures at depths and on dates of collection of young-of-the-year lake trout off Laughing Fish Point ranged from 42° to 63° F.

Most I- and II-group lake trout taken in trawls were caught in Keweenaw Bay at Depths of 20-34 fathoms. Gill-net catches here and in other areas supported trawling results in showing the relatively

greater abundance of II-group lake trout in the 20-34-fathom interval than at other depths. At these depths temperatures ranged from 39° to 53° F. in Keeweenaw Bay and from 39° to 43° F. at stations near Isle Royale, on dates when small lake trout were collected.

Young-of-the-year lake trout in the 1953 collections near Laughing Fish Point increased in mean total length from 1.2 inches on June 22-23 to 3.1 inches on October 21-22. The greatest rate of increase (4 millimeters per week) occurred between July 22 and September 14. Yearlings in Keweenaw Bay were 3.9 inches long on May 11-12 and 5.6 inches on October 15; for 2-year-old fish these lengths were 6.7 and 8.0 inches, respectively. Lake trout of the II group collected near Isle Royale were markedly shorter than fish of the same age collected on similar dates in Keweenaw Bay. A comparison of length of lake trout in October with length in May, before new growth had occurred, strongly suggests that the growing season of small lake trout continues to or beyond the end of the calendar year. The average lengths of 1-, 2-, and 3-year-old lake trout caught in Keweenaw Bay in May 1953 were 3.9, 6.7, and 8.6 inches, respectively.

The opossum shrimp (Mysis) was by far the most important food of small lake trout from Lake Superior. It was in 70 percent of the stomachs and made up 84 percent of the food volume in 325 young-of-the-year lake trout; for 392 I- and II- group fish these percentages were 95 and 82, respectively. Other crustacea, insects, and fish were less important in the diet.

Cottids, ninespine sticklebacks, smelt, coregonides, trout-perch, and older lake trout were the most common associates of lake trout during their first three summers of life in Lake Superior. (A)

838. Anonymous. 1956. NATIONAL SURVEY OF FISHING AND HUNTING. U. S. Fish and Wildlife Cir., No. 44, 50 pgs.

This is a summary of data collected in January and February 1956 by Crossley S-D Surveys, Inc., under contract with the Fish and Wildlife Service. The report shows the number of households in which one or more persons fished or hunted, the number of persons who fished or hunted, how far they traveled to fish or hunt, and how many days of fishing and hunting they enjoyed. All data were collected by personal-interview of fishermen in a sample of households throughout the United States. Projections to national and regional totals were made by standard statistical procedures.

Of 118,366,000 persons 12 years old or older in the United States, 20,813,000 fished in 1955 and spent 2 billion dollars. Those who fished in fresh water totalled 18,420,000 and spent an average of $77.38, while 4,557,000 fished in salt water spending an average of $107.29. Average expenditure per day for all fishermen was $4.82; the average expenditure per day for fresh-water fishermen was $4.20 and that for salt water fishermen was $8.35. The average number of days an angler went fishing in 1955 was 19.1 days (median 9.5 days); salt water anglers spent 12.9 days and fresh-water anglers spent 18.4 days. The total number of days expended in fresh-water fishing was 338,826,000 and in salt-water fishing was 58,621,000. (Ed. note--copies of this report may be obtained for $.40 by writing the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.)

839. Mansueti, Romeo. 1955. MARYLAND NATURAL RESOURCE BIBLIOGRAPHY. Resource Study Rep. No. 7, Md. Dept. of Res. and Education, April, 27 pgs.

This is a guide to key works concerned specifically with Maryland and dealing with zoology, botany, geology, and related subjects.

840. Seguin, Louis-Roch., 1954. ARTIFICIAL FEEDING OF THE SPECKLED TROUT (SALVELINUS FONTINALIS, MITCHILL). Faculty of Sci., Univ. of Montreal (Can.), March, p. 124.

The following abstract is based on a translation from Bulletin francais de Pisciculture (Paris), 30 September 1955, pp. 37-38, by P. Vivier, Water and Forest Conservationist and Chief of Fishery Research, Paris, France.

The feeding demands of this salmonid, the food value of the different products, and the physical qualities of selected diets are discussed. The methods used to determine the value of a diet are also described. The main part of this work is concerned with feeding experiments. Seventeen groups of fish, ranging from 1,000 to 32,000 individuals each, were fed diets varying in composition. Components of these diets were meat, fish, milk, and cereal meals, and cod liver, horse liver, pork spleen, and fish.

The author concluded that meat diets are generally the best, liver of beef being most desirable. Food mixtures including meals also gave equally excellent results. Addition of fish to a diet did not improve the diet. Whole cod liver, when used as a substitute for meat, helped the growth of fish for some time but eventually was harmful to its health. The most promising diet is that which included meals given in the form of pellets. This proved markedly superior to the 100 percent meat diet and twice as good as a diet of identical composition but given in the form of meals mixed with meat. An important contribution which these experiments have given to food research is that of showing the importance of finding a way of making and giving to the fish a food which can be eaten rapidly and completely, in the form in which it is made.

841. Copley, Hugh. 1956. REVIEW OF KENYA FISHERIES, 1955. A 45-pg. booklet published by the Colony and Protectorate of Kenya, Nairobi.

This is an annual review of activities and progress covering both marine and fresh-water fisheries. Studies are being conducted on the effects on fish of cetyl alcohol, now being used in experiments to control evaporation from reservoirs. Preliminary findings indicate no ill effects

on Tilapia nigra.

The method for determining the sex of T. nigra as small as 6 cm. is described and closely parallels that for T. mossambrica. The female of both species has three openings in the anal region, the anus, an abdominal pore, and an oviduct opening between these two discernible as a small slit; the male fish has only the first two. Drawings of the anal openings are presented. Culture of male Tilapia has resulted in an increase in growth up to 28-30 cm. at an age of 9-10 months. Monosex culture of Tilapia may prove to be the answer to over-population problems resulting from their high reproductive potential.

842. Ayers, H. D and A. deVos. 1956. FARM PONDS—THEIR CONSTRUCTION AND MANAGEMENT. Ontario Dept. of Agric. Bull. 515, July, 23 pgs., illus.

This bulletin discusses in some detail and with illustrative aid the source of water; selection of the pond site; soil; topography; proposed pond uses; water supply; construction of spillways, and impounded and excavated ponds; the procedure for construction; management considerations for fish and wildlife; and legal aspects of water use.

843. Mansueti, R. J. 1956. ALEWIFE HERRING EGGS AND LARVAE REARED SUCCESSFULLY IN LAB. Md. Tidewater News, Vol. 13, No. 1, June, pp. 2-3.

The eggs of Pomolobus pseudoharengus were heavier than water and were slightly adhesive until milt was added. The outer membrane of the egg expanded to almost exactly one millimeter in diameter after "water hardening." Development within the yolk was rapid, for the animal pole divided in such a manner that the 32- and 64-cell stages were observed three or four hours after fertilization at an average temperature of about 60° F. Embryos were well developed 30 or 35 hours after fertilization, at 60° F. Almost two days after procuring the eggs, the larvae began to hatch and all had hatched in the following three days.

The larval alewives were tiny, transparent, and elongate with large eyes and an enlarged yolk sac, were about 4 mm. in total length after hatching, and in a week and a half grew 2 mm. The only markings on the otherwise colorless body were black pigment cells behind the eyes, along the ventral portion of the body to the vent, and on the ventral part of the tail. Such markings are useful in distinguishing this species from other herring-like larvae. Within 4 or 5 days the yolk sac was almost completely absorbed, but prior to this period, the larvae swam about actively wriggling like microscopic eels. Larvae were maintained alive for over 2 weeks.

844. Mansueti, R. 1956. HICKORY SHAD EGGS AND LARVAE REARED SUCCESSFULLY IN LAB. Md. Tidewater News, Vol. 13, No. 1, pp. 1 and 3.

Only about 5 percent of the eggs spawned into large finger bowls and fertilized seemed to be fertile and in good condition. The eggs, about $1\frac{1}{2}$ mm. in diameter, were perfectly transparent with a large yolk mass. Three hours after fertilization at 64° F., 4- and 8-cell stages were observed, and about 9 hours later, cell divisions were no longer visible, indicating an advanced state. About 20 hours later, an early-stage embryo was evident, and about 35 hours after fertilization, it was well formed and transparent with large eyes, long tail, pulsating heart, and no pigment. The larvae began hatching when they were about 50 hours old, some breaking out tail first and others head first.

Larval hickory shad, about 6 mm. in length at hatching, seemed very much like larval Atlantic shad and branch herring. About 10 or 20 hours after hatching the vertebrae were evident, and very fine black pigment cells were observed on the yolk sac or belly, along the margin of the intestine, and on the tail region. Eight days after the eggs were fertilized, the yolk sac was completely absorbed and fish were elongate and transparent, with the exception of the markings cited and had grown a little over $\frac{1}{2}$ mm. Efforts to feed them shortly after hatching with brine shrimp mauplii were unsuccessful. All fish perished by May 19.

Egg and larval collections made at Queen Anne's Bridge, upper Patuxent River, in the spring of 1953 and 1954 contained a number of relatively large clear eggs that did not fit the descriptions of those produced by Atlantic shad and branch herrings. With a knowledge of the size and characteristics of eggs of Atlantic shad - $3\frac{1}{2}$ mm. in diameter, alewife herring - 1 mm., and glut herring - 1 mm., the unknown eggs were determined to be hickory shad eggs.

845. Clemens, Howard P. and Joe C. Finnell. 1956. BIOLOGICAL CONDITIONS IN A STREAM RECEIVING REFINERY EFFLUENTS. The Texas J. of Sci., Vol. 8, No. 4, Dec., pp. 392-398.

Studies on an unnamed tributary of the Little Washita River revealed 31 different kinds of organisms above the source of refinery effluents and only 11 below. Organisms apparently eliminated at the point where wastes entered included 7 species of fish, 1 coelenterate, 1 protozoan, 9 rotifers, and 3 crustaceans. Pimephales promelas, Notropis lutrensis, and Fundulus kansae, were the most tolerant fish, being found in all but the most polluted sections; Notropis deliciousus and Lepomis cyanellus were found only in unpolluted sections. Relative tolerance of other organisms is given. It is concluded that refinery wastes limited the number of kinds of organisms as well as the number of each kind.

846. Hubbs, Clark. 1956. RELATIVE VARIABILITY OF HYBRIDS BETWEEN THE MINNOWS, NOTROPIS LEPIDUS AND N. PROSERPINUS. The Texas J. of Sci., Vol. 8, No. 4, pp. 463-469.

A single sample of 26 first generation hybrids between closely related minnows, Notropis lepidus and Notropis proserpinus, is not only more variable than any available sample of either parental

species but also greatly exceeds the parental species in one taxonomic character, anal ray count. Absence of pelvic fins in 23 of the 26 hybrids is noted. Three possible genetic causes for the increased variability and the effect of environmental conditions in the laboratory as an other possible cause are discussed.

847. Foskett, D. R. 1955. AGE AND SIZE OF BELLA COOLA SOCKEYE SALMON. Prog. Rep. of the Pacific Coast Stations, No. 102, March, pp. 16-19.

Age, length, and weight distribution are presented by sex for gill netted fish taken in 1951, 1952, and 1953 in the Bella Coola area of British Columbia.

848. McCracken, L. H. 1955. THE SALINITY OF SEA WATER. Prog. Reps. of the Pacific Coast Stations, No. 102, March, pp. 24-26.

As the ratio of the different major dissolved salts in sea water is virtually constant regardless of the absolute concentration, the salinity of sea water may be determined by tritration for one of its principle constituents, usually the chloride ion. Chlorinity, the chloride ion concentration determined by tritration with silver nitrate, may be readily converted to salinity by using the formula: Salinity = 0.030 + 1.805 x chlorinity.

849. Anderson, William W., Jack W. Gehringer and Edward Cohen. 1956. PHYSICAL OCEANOGRAPHIC, BIOLOGICAL AND CHEMICAL DATA SOUTH ATLANTIC COAST OF THE UNITED STATES M/V THEODORE N. GILL CRUISE I. U. S. Fish and Wildlife Service Spec. Sci. Rep. - Fish., No. 178, Aug., 160 pgs.

This report describes the chemical, biological, and oceanographic methods and procedures followed during this investigation, the ultimate objective of which is to ascertain the potential productivity of those waters adjacent to the Atlantic Coast from Cape Hatteras south to the Florida Straits. Data obtained is presented in tabular form for each station.

850. Applegate, Vernon C. and James W. Moffett. 1955. THE SEA LAMPREY. Sci. Amer., Vol. 192, No. 4, April, pp. 37-41.

This article presents a brief resume of the decline of the lake trout fisheries of Lake Huron and Lake Michigan, the life history of the sea lamprey, and the methods attempted and those now being used in control of the lamprey. Complete eradication of sea lampreys from the Great Lakes above Niagara Falls is the objective of the program.

851. White, David L. 1955. NEW HAMPSHIRE'S 22 MILLION DOLLAR SPORTSMEN. Tech. Cir. No. 11-a of the Mgt. and Res. Div., N. H. Fish and Game Dept., 14 pgs.

A mail questionnaire survey conducted in 1952 revealed that licensed sportsmen, both resident and non-resident, spent $22,452,000. This report presents total expenditure and average expenditure per sportsman figures for both resident and non-resident licensees broken down into the following categories—food and lodging, transportation, arms and ammunition, boats and motors, fishing tackle, sportswear, dogs and dog maintenance, drinks, extra smokes, accessories, clubs and magazines, etc., bait, camp gear, and guide service. The percent of respondents reporting an expenditure in a certain category is also given. The technical publication "How New Hampshire Attached the Dollar Sign to its Fish and Wildlife," is available from the New Hampshire Fish and Game Department.

852. Atton, F. M. and R. P. Johnson. 1955. FIRST RECORDS OF EIGHT SPECIES OF FISHES IN SASKATCHEWAN. Reprinted from The Canad. Field-Nat., Vol. 69, No. 3, July-Sept., pp. 82-84.

These eight new records are: silver redhorse (Moxostoma anisurum), golden shiner (Notemigonus crysoleucas), common shiner (Notropis cornutus), sand shiner (Notropis deliciosus), brown bullhead (Ameiurus nebulosus), blackside darter (Hadropterus maculatus), and fresh-water sheepshead (Aplodinotus grunniens). This adds two families and five genera to the fish fauna of the province.

853. Allen, K. Radway. 1956. THE CLASSIFICATION OF FRESH-WATER HABITATS. Reprinted from Proc. of the N. Z. Ecol. Soc., No. 3, March, pp. 24-25.

Any scheme in the classification of fresh-water habitats should be based on the environmental factors which are of the greatest direct influence on the animals concerned. Physico-chemical factors, the result of topographic and geological structure of the locality, are virtually uninfluenced by vegetation and other biotic features important to the land animal. Factors to be considered in fresh-water habitat classification include water movement, temperature, oxygen concentration, pH, substratum, and food supply.

854. Hobbs, D. F. 1955. DO NEWLY INTRODUCED SPECIES PRESENT A SEPARATE PROBLEM? Reprinted from Proc. of the N. Z. Ecol. Soc., No. 2, pp. 12-14.

The author found little evidence in the literature to suggest that newly introduced species possess any special problems in population dynamics; little distinction is made between indigenous and introduced populations. It appears that there could be dangers in failing to appreciate certain differences which seem to warrant separate consideration of the dynamics of newly introduced populations. Some of the more important aspects are that extinction of indigenous species is rare while extinction of introduced species is common, that indigenous species have a relatively high population minimum in contrast to a usually very small initial population nucleus for exotic species, that indigenous populations confine population increases to relatively short periods while it is often pro-

tracted for introduced species, that fluctuations in a native population involve increases of a temporary nature while that for introduced species is often permanent involving extension of range, that the environment is conditioned by use of indigenous populations while it has yet to be conditioned by introduced species, and that natural enemies of indigenous species are present but natural enemies often arrive later for exotics. This points up the need for closer research interest in the dynamics of new populations.

855. Mendis, A. S. 1956. A LIMNOLOGICAL COMPARISON OF FOUR LAKES IN CENTRAL SASKATCHEWAN. Fish. Rep. No. 2 of the Fish. Br., Dept. of Natural Resources, Saskatchewan, 23 pgs.

Four lakes in central Saskatchewan representative of different physiographic regions and dissolved-solid content were chosen for study. Water of Wakaw Lake which has an area of 4.0 square miles is high in dissolved solids, while waters of Sturgeon Lake, 2.2 square miles, and Montreal Lake, 170.5 square miles, have low quantities of dissolved solids. Bigstone Lake with an area of 7.5 square miles is lower in dissolved solids than the other three. Each lake was examined three times during the summer of 1955. Geography and morphometry, physical and chemical conditions, plankton, bottom fauna, and fish fauna of each lake are compared. It is concluded that the three smaller lakes are eutrophic with Montreal Lake being best described as mesotrophic approaching eutrophy. Other findings of the study are related to problems of fishery management in each lake.

856. Buck, D. Homer. 1956. EFFECTS OF TURBIDITY ON FISH AND FISHING. Trans. of the Twenty-first N. A. Wildlife Conf., March, pp. 249-261.

Thirty-nine farm ponds, rotenoned and then stocked with largemouth bass and bluegill or largemouth bass and redear sunfish were classified into clear ponds-turbidities less than 25 ppm., intermediate ponds-turbidities from 25 to 100 ppm., and muddy ponds-turbidities in excess of 100 ppm. At the end of two seasons, the average total weight of all fish in clear ponds was about 1.7 times greater than in intermediate ponds and 5.5 times greater than in muddy ponds. Largemouth bass were harmed the most by turbidity in both growth and reproduction. Average volume of net plankton in surface waters of clear ponds was 8 times greater than in intermediate ponds and 12.8 times greater than in muddy ponds.

Studies in hatchery ponds revealed that high turbidities reduced growth and yield of bass and bluegills. It favored channel catfish production due to higher survival of young, but not growth. Studies in turbid Heyburn Reservoir and clear Upper Spavinaw Reservoir resulted in similar findings. The clear reservoir attracted more anglers and yielded greater returns per unit of fishing effort as well as more desirable species than the turbid reservoir.

857. Carlander, Kenneth D. 1956. APPRAISAL OF METHODS OF FISH POPULATION STUDY - Part I. (Fish growth studies). Trans. Twenty-first N. A. Wildlife Conf., March, pp. 275-281.

Of the three major methods of aging fish, direct observation, length-frequency analysis, and interpretation of growth rings on scales, bones, and fin rays, the third has the most general application. Equipment need not be elaborate, but considerable judgment must be exercised in interpreting growth rings. Supporting data should be secured in each study. Two independent, unbiased readings of the rings may increase the accuracy of interpretation. Comparison of growth rates is complicated by the fact that growth may vary in different ways and at different stages in life.

Because of the great variability in growth rates of individual fish within the same population, samples for study need to be fairly large. Since most collecting methods are selective, the biologist must determine what segment of the population is being sampled and interpret the results accordingly.

In lake and stream surveys, growth studies provide information on general conditions affecting fish and evaluation of management programs. Slow growth often indicates the need for management practices which will reduce population density. Where data are to be used as standards for comparisons, care should be taken to not sample too many "problem" waters. The greatest need is more planning of investigations and more critical analysis of results. (A)

858. Cuerrier, J. P. 1956. APPRAISAL OF METHODS OF FISH POPULATION STUDY - Part II. (Creel censuses). Trans. Twenty-first N.A. Wildlife Conf., March, pp. 262-274.

In order to gather information which may assist in formulating better management programs for better angling, creel census data are collected from anglers. Several methods of collecting this information have been designed. The voluntary return method used in the National Parks of Canada during the past 15 years is discussed and appraised. Examples where creel census records have been most valuable in following up angling activities and in planning and carrying out the management of game fish in park waters are reported. The method, however, has limitations, and creel census reports had to be supplemented by sampling through standard methods. Only where officers were available for obtaining a fairly complete coverage on angling activities and catches creel census data were of some use. The collection of data by the voluntary return method from all park waters is being discontinued. Data are now collected only where and when needed for research and for evaluating management practices. (A)

859. Cooper, Gerald P. and Karl F. Lagler. 1956. THE MEASUREMENT OF FISH POPULATION SIZE. Trans. Twenty-first N. A. Wildlife Conf.,

March, pp. 281-297.

Laboratory models using beans as "fish" and pail as a "body of water" were employed to study the behavior of the so-called DeLury, Petersen, Schnabel, Schumacher-Eschmeyer methods for the estimation of fish population numbers. Use of these methods in the field can give no better results than those attained in models. Data from models can be used to judge the normalcy of field data. Evaluation of empirical field data showed that the Peterson method gave least reliable numerical estimates of population when based on the total size range as a single group. It gave best results when individual size-groups within the population were treated separately. In applying the indirect methods of population estimates cited it appears that it is necessary to extend and/or intensify the mark-and-recapture techniques more than is commonly done if "good" estimates of population number are to result. (A)

860. Swingle, H S. 1956. DETERMINATION OF BALANCE IN FARM FISH PONDS. Trans. Twenty-first N. A. Wildlife Conf., March, p. 298.

Methods of determination of balance include: a seining technique called pond analysis; the use of catch records; calculation of population values and ratios from samples of the population; and the marking and recovery technique. Pond analysis is based upon the factors affecting reproduction of pondfishes and the state of balance is deduced from seining samples. The factors affecting reproduction discussed are: size of brood fish, rate of growth, crowding, egg-eating habit, repressive factor, temperature, silt, water fluctuation, salinity, pH and light. Catch records indicated the state of balance when there was adequate fishing effort. Population values calculated from samples of the populations were valuable in measuring balance. Estimation of population by marking and recovery gave values varying from 32 to 222 percent of the actual numbers of fish present. (A)

861. Suttkus, Royal D 1956. EARLY LIFE HISTORY OF THE GULF MENHADEN, BREVOORTIA PATRONUS IN LOUISIANA. Trans. Twenty-first N. A. Wildlife Conf., March, pp. 390-407.

The study of the Gulf menhaden was conducted on Lake Pontchartrain and neighboring waters during 1953-1955. The catch records and observations made in the Lake Pontchartrain area indicate that menhaden do not spawn in the lake. However, the larvae appear each year and apparently remain in the lake for their first summer of life and then move out during late fall. The menhaden larvae (15-25 mm. in total length) made their appearance in the lake in December of each of the 2 years under observation. Individuals of approximately the same size enter the lake from December until the month of March. Presumably spawning (no direct observations) ceases during the month of February. This report includes length-frequency distributions, changes in meristic counts, changes in pigmentation and relative density of populations in Lake Pontchartrain. (A)

862. Carritt, Dayton E. 1956. RECENT DEVELOPMENTS IN THE CHEMISTRY AND HYDROGRAPHY OF ESTUARIES. Trans. Twenty-first N. A. Wildlife Conf., March, pp. 420-436.

This paper brings together for purposes of comparison several groups of studies having inherent features that contribute much to the basic problems of prediction of estuarine properties. Studies in estuarine hydrography which deal with the circulation within estuarine systems, with the mixing processes between fresh and sea water, and with the relations between these properties and those that are thought to control circulation and mixing are covered. The problems encountered in sampling for chemical studies and the techniques developed and found satisfactory to overcome some of the difficulties are described.

863. Hall, Gordon E., Robert M. Jenkins and Joe C. Finnell. 1954. THE INFLUENCE OF ENVIRONMENTAL CONDITIONS UPON THE GROWTH OF WHITE CRAPPIE AND BLACK CRAPPIE IN OKLAHOMA WATERS. Okla. Fish. Res. Lab. Rep. No. 40, March, 56 pgs.

Scales from 10,560 white crappie from 130 bodies of water and 2,406 black crappie from 83 bodies of water, captured by various means during the period 1946-1953, were employed in determining average rates of growth of these species under various environmental conditions in Oklahoma. Growth was calculated to each annulus, and all averages presented are based on weighted average calculated lengths at the end of each year of life from each body of water. Fish collected between November and time of annulus formation were considered as having completed another year's growth. Time of annulus formation of white crappie appears to center in a period from the middle of April to the first of May, approximately a month earlier than was previously determined for Oklahoma largemouth bass.

Of the total collection, 97 percent of the white crappie and 98 percent of the black crappie were less than 5 years old. White crappie averaged 2.9 inches in total length at the end of the first year of life and during successive years averaged 5.9, 7.8, 9.8, 11.9, 13.2, 14.2, and 15.0 inches. Black crappie averaged 3.1 inches at the end of their first year of life, and at the end of succeeding years averaged 6.3, 8.2, 9.9, 11.6, 13.5, and 15.2 inches. The length-weight relationship of the white crappie is expressed by the equation log $W = -5.0246 + 3.3685 \log L$ (total length) and that of the black crappie by the equation $\log W = -4.9495 + 3.3408 \log L$. At equal lengths black crappie are slightly heavier than the white crappie. Comparison of growth of Oklahoma crappies with that of crappies in other States showed that in Oklahoma average growth of white crappie was generally slower and that of black crappie usually faster than elsewhere.

In Oklahoma impoundments of various sizes white crappie grew faster in ponds and small lakes than in large lakes, whereas the reverse is true for black crappie. Both species grew slowest

in large, turbid lakes of the 110- to 500-acre class. Other environmental factors, including age and turbidity of water, appeared to influence rate of growth of both species more than the water area. Growth-rates were much faster in waters impounded less than 4 years than in older waters. The majority of poor-growing crappie populations were found in turbid waters. Above average growth occurred in all clear lakes over 1,000 surface acres, and in small ponds and lakes with very limited crappie populations. Black crappie appear to prefer clear-water habitats since 82 percent of the samples of this fish came from clear waters. White crappie were found more widely distributed in both clear and turbid waters, although better rates of growth were attained in clear waters.

864. Laycock, Harold C. 1956. CETYL ALCOHOL CONTROLS EVAPORATION. Water and Sewage Works, Vol. 103, No. 8, Aug., pp. 346-347.

Experiments on the use of cetyl alcohol, a product of sperm whale oil, to limit surface evaporation from large bodies of water are in progress. Tests on 4-foot diameter evaporation plans revealed an average reduction in evaporation of 50 percent, and up to 70 percent on hot sunny days, as a result of a mono-molecular film of cetyl alcohol. (Interest in the use of cetyl alcohol in southwestern United States is increasing. It is reported to be harmless to fish life. Ed. note.)

865. Anonymous. 1956. AUSTRALIAN WATER CONSERVATION METHOD. Sci., Nov. 30, p. 1071.

Richard G. Casey, Australian Minister in Charge of Industrial Scientific Research, reported at a UNESCO symposium on climatology in Camberra, Australia, that cetyl alcohol is invisible, tasteless, and harmless to animal life. It forms a film in water preventing evaporation, but permitting oxygenation. Tests during the last 2 years in dams and reservoirs have shown a reduction in evaporation of between 20 and 70 percent.

866. Finnell, Joe C. 1954. COMPARISON OF GROWTH-RATES OF FISHES IN STRINGTOWN SUB-PRISON LAKE PRIOR TO, AND THREE YEARS AFTER DRAINING AND RESTOCKING. Reprint from Proc. of the Okla. Acad. of Sci., Vol. 35, pp. 30-36.

The stunted population of this 60-acre lake was rotenoned in 1950 and restocked in 1951 with largemouth bass, channel catfish, black crappie, and redear sunfish. Age and growth rates for species taken in 1950 were compared with those for fish taken in rotenone sampling in 1954. Accelerated growth commonly associated with new impoundments was exhibited by all four species stocked. Of the stocked fish, which were one year old when planted, only black crappie showed evidence of having spawned the following spring while largemouth bass and redear sunfish spawned in 1953. Channel catfish had not spawned. Seven other species have repopulated the lake, possibly remnants of an incomplete kill in 1950.

867. Jackson, Samuel W., Jr. 1954. ROTENONE SURVEY OF BLACK HOLLOW ON LOWER SPAVINAW LAKE, NOVEMBER, 1953. Reprint from Proc. of the Okla. Acad. of Sci. for 1954, pp. 10-14.

This water supply reservoir covers 1,637 acres. The 8-acre area in Black Hollow cove which was rotenoned yielded 21,674 fish weighing 4,326 pounds, or 2,709 fish and 541 pounds per acre. Gizzard shad dominated the collection constituting 90 percent of the total number and 78.5 percent of the total weight. Largemouth bass was the second most numerous fish comprising 2.2 percent by number and 1.8 percent by weight. Only three other species, freshwater drum, spotted sucker, and white bass, composed more than 1 percent of the total number. Average growth rates for 17 species collected are presented.

868. Jenkins, Robert M. 1954. AN ESTIMATE OF THE FISH POPULATION IN A FORTY-FIVE-YEAR-OLD OKALHOMA POND. Reprint from the Proc. of the Okla. Acad. of Sci., Vol. 35, pp. 69-76.

Seining and marking prior to rotenoning this 2.15-acre pond provided population estimates. Complete dominance of bluegill over largemouth bass, warmouth, and white crappie was indicated. The standing crop was estimated at 357 pounds per acre (450 pounds per acre at the water level at time of reclamation), 88.5 percent of which was bluegill. Of 8,273 individuals in the pond, 13 largemouth, 5 white crappie, 8 warmouth, and 1,130 bluegill were of desirable size. All species except bass exhibited fast growth during the first two years of life; only one fish was in its fifth summer indicating early mortality. All fish were in poor condition. Stocking Oklahoma ponds with these species does not seem desirable unless the bluegill population can be controlled.

869. Elkin, Ronald E., Jr. 1954. THE FISH POPULATION OF TWO CUT-OFF POOLS IN SALT CREEK, OSAGE COUNTY, OKLAHOMA. Reprint from Proc. of the Okla. Acad. of Sci., Vol. 35, pp. 25-29.

The surface area of the two pools rotenoned was 0.172 acres. Maximum depth of one pool was 50 feet, the other 4.5 feet. Thirty-six species were collected. The two pools produced 41.7 pounds of fish, equivalent to 242 pounds per acre. Game fish comprised 45 percent by number and 54 percent by weight of the total sample, both considered abnormally high for this tributary to the Arkansas River.

870. Ridenhour, Richard L. and Charles J. Di Costanzo. 1956. NYLON VS. LINEN GILL NETS AT CLEAR LAKE, IOWA. Reprinted from the Proc. of the Iowa Acad. of Sci., Vol. 63, Dec. 6, pp. 700-704.

Each gill net was 125 feet long and 6 feet deep consisting of five 25-foot sections of 0.75, 1, 1.25, 1.50, and 2-inch bar measure. Nets were set in 7 basic locations each summer in 1954 and 1955.

Nylon and linen nets were set in such manner as to minimize the advantage one might have over the other.

The ratio of nylon to linen catches for both years was 1.72:1; in 1954 it was 1.96:1 and in 1955, 1.34:1. This exhibits what others have noted, the greater efficiency of nylon netting. If the only consideration is a larger sample of fish, nylon nets are indicated. However, other factors should be considered in most instances. Nylon nets were best from the standpoint of rot resistance, but fish removal and net handling tended to damage nylon nets more than linen. Nylon nets held fish more securely, probably one reason for their greater efficiency, but resulted in greater damage to the fish caught. Cost of nylon was greater than linen. Chi-square tests, however, indicated that species composition was independent of the netting material. Each type could seem to have a place

871. Pulford, Earl F. 1955. ESCAPEMENT OF SPRING CHINOOK SALMON AND STEELHEAD OVER WILLAMETTE FALLS IN 1953. Res. Briefs, Fish Comm. of Oreg., Vol. 6, No. 1, Nov., pp. 19-28.

The period of major migration of spring chinook salmon over Willamette Falls in 1953 extended from April 15 to July 5, with 4 major peaks of abundance. A total of 76,400 spring chinook salmon, including 72,300 adults and 4,100 jacks was calculated to have migrated over Willamette Falls fishway. This escapement surpassed that of any in recent years, and only the 53,000 escapement in 1946 and the 52,200 in 1952 approached this figure. The last two cyclic returns, 1947-52 and 1948-53, indicate increasing returns.

The average half-hourly counts indicated that the morning migration started at a slow rate, increased rather abruptly between 7:00 and 8:00 a.m., continued to increase gradually until about 2:00 p.m.; and then remained at a relatively constant rate until the end of the counting period at 8:00 p.m. At the approach of darkness the migration fell off sharply. Each night's migration was calculated to be 31.1 percent of the preceding afternoon's count (noon—8:00 p.m.). This factor is based upon three 24-hour counts in 1953 and eight similar counts in previous years A sudden increase in the numbers of jacks counted accompanied the approach of the end of adult migration. An estimated 1,200 steelhead passed over Willamette Falls during the period of counting, excluding the night migrations. As only the end of the run was recorded, no estimation of the total escapement is available. (A)

872. Wood, James W., Wallace F. Hublou, Thomas B. McKee, Russell O. Sinnhuber, and Duncan K. Law. 1955. FOURTH PROGRESS REPORT ON SALMON DIET EXPERIMENTS. Res. Briefs, Fish Comm. of Oreg., Vol. 6, No. 1, Nov., pp. 29-32.

This study was designed to evaluate several common hatchery foods for raising spring chinook salmon under cold water conditions. One control and five experimental diets were chosen. The components included beef liver, Argentine beef liver meal, shad, and chinook salmon flesh, salmon viscera, and salmon meal. Three diets were designed to study levels of beef liver that might be used to raise spring chinook salmon satisfactorily during periods of cold water. One diet was composed of shad flesh, beef liver meal, and salmon viscera. The final diet contained salmon and wheat germ meals in combination with salmon products and beef liver. These last two diets were preliminary evaluation tests and were not meant to be compared with each other or with the other four diets.

There appeared to be little correlation between the amount of beef liver fed and the resulting growth under the conditions of this experiment. However, the lowest level of beef liver fed, 10 percent with other components, provided good growth. This is an important observation since beef liver is an expensive hatchery food and the supply is limited.

The diet containing Argentine beef liver meal and 30 percent shad provided poor growth. The fish were sluggish and in poor condition. This may be due to the presence of the vitamin B_1 destroying enzyme, thiaminase, in shad. Shad is a member of the herring family and several members of this group are known to contain thiaminase. The diet containing salmon meal and wheat germ meal in conjunction with other hatchery food ingredients gave good growth. The control diet, 98 percent beef liver with 2 percent salt, provided only moderate growth under the cold water conditions prevailing.

873. Charrett, John T. 1955. THE TRANSFER OF HATCHERY FISH TO ESTUARINE WATERS. Res. Briefs, Fish Comm. of Oreg., Vol. 6, No. 1, Nov., pp. 14-18.

The feasibility of planting hatchery-reared chinook salmon and silver salmon less than 1 year old directly into estuarine waters was tested during 1948 and 1949 by placing young of these species in live boxes in the estuary of the Nehalem River. Live boxes were attended and fish were fed every second or third day or at times after a greater interval of time. Specific gravity and temperature records were kept.

Results of the several experiments were somewhat inconsistent and for this no explanation is offered. However, some of the experiments suggest that 0-age group silver salmon can be successfully introduced in the fall of the year without serious loss. There are some indications that 0-age group fall- and spring-run chinook plants might also be successful. Success seemed to increase as the season progressed but data do not permit a conclusion as to whether this is a function of size and/or age of the fish, water conditions, or a combination of them.

874. Wales, J. H. and E. R. German. 1956. CASTLE LAKE INVESTIGATION—SECOND PHASE: EASTERN BROOK TROUT. Calif. Fish and Game, Vol. 42, No. 2, April, pp. 93-108.

During this phase of the investigation, cover-

ing the period 1947-54, inclusive, the results from planting brook trout have been markedly different from those which were obtained prior to 1946, when the lake was treated with rotenone and all four species of trout removed. In 1947 both brook trout yearlings and fingerlings were planted and in 1948 more fingerlings were planted, giving a total of 60,000 fish. The present report is based upon the returns to anglers of these fish during the ensuing eight years.

During the three years 1949-51 no trout were planted in Castle Lake. In 1952 the first of a series of rainbow trout plants was made and in the years 1952-54 both brook and rainbow trout were caught. As late as 1954 some of the marked brook trout planted in 1947 and 1948 were being caught but most were naturally spawned in the spring areas of the lake bottom. The yearling brook trout planted in 1947 were of "subcatchable" size, averaging 13 per pound. However, many were larger than this and catches were heavy from the time of liberation. This group contributed to the catch for at least four years and the total return to the fishermen was 48.3 percent. The fingerlings planted in 1947 and 1948 were caught during seven seasons following the liberations and the final returns were 34.6 and 36.4 percent, respectively.

The removal of the highly predatory brown and lake trout in 1946 increased the survival of the fingerling brook trout to the anglers' catch from an average of 1.9 percent to approximately 35 percent. The survival of the yearling brook trout was not markedly affected. Before the lake was treated their survival was 40 percent, while following treatment it was 43.8 percent.

The 1948 plant of fingerlings was divided, with one half marked by removal of the adipose fin alone and the other half by removal of the adipose and left ventral. During the ensuing seven years 34.1 percent of those with the adipose removed were caught, while the other group contributed 38.7 percent. We may conclude that removal of a ventral fin and the adipose does not cause a greater mortality than removal of the adipose fin alone. Similarly, the growth rates of the two groups were practically identical.

Following treatment of Castle Lake with rotenone, the food supply was reduced. This, together with overstocking in 1947, caused the yearlings to grow slowly and to have a low condition factor. The growth of the fingerlings planted in 1947 was slower than that of the fingerlings stocked in 1948. The average fork length of all brook trout caught during the period 1947-54, inclusive, was 7.0 inches. Few of the fish reached a foot in length and the largest taken was 18.4 inches long.

In common with many similar lakes in California, an initial planting of brook trout resulted in a self-propagating population which by itself provided moderately good fishing. In 1954, 84 percent of the catch was composed of brook trout, nearly all of which were naturally spawned. Although 1,503 pounds of yearling brook trout were planted in 1947, only 978 pounds of fish from this plant were eventually caught by anglers. In marked contrast, 100 pounds of brook fingerlings planted in 1948 yielded 923 pounds caught by anglers.

In computing the following costs for each fish caught by anglers in Castle Lake, it is estimated that the fingerlings cost one cent and the yearlings 15 cents each at planting time. Prior to treatment, fish caught that were planted as fingerlings cost $0.525, and yearlings, $0.375, while after treatment fingerlings cost $0.03 and yearlings $0.35. The average annual yield of brook trout to the anglers prior to the planting of rainbow was 493 pounds, or 10.3 pounds per acre. It is already evident that the yield in pounds per acre following the planting of rainbow in 1952 will be considerably greater than it was when brooks alone were planted. (A)

875. Best, E. A. and H. D. Boles. 1956. AN EVALUATION OF CREEL CENSUS METHODS. Calif. Fish and Game, Vol. 42, No. 2, April, pp. 109-115.

This paper describes four partial creel census methods and the results that may be expected from them. The analysis uses actual and hypothetical data in comparing an unstratified sample, stratification by calendar months, stratification by week ends and week days, and 5-day per week methods. It is concluded that in lakes and streams in which fishing pressure is relatively light, partial creel censuses which include less than 25 percent of the fishing days may not yield entirely adequate data.

The present study indicates that when monetary or other considerations limit the number of census days to approximately 40 in a 6-month angling season, the best over-all coverage of the entire season will be obtained from a creel census involving stratification by calendar months. A 5-day-per-week check which includes all week ends and holidays will provide more accurate results. Even this more intensive survey of angling activity, however, may yield estimated totals that deviate as much as 12 percent from the known totals.

876. Morris, Robert W. 1956. EARLY LARVAE OF FOUR SPECIES OF ROCKFISH, SEBASTODES. Calif. Fish and Game, Vol. 42, No. 2, April, pp. 149-153.

A taxonomic discussion of larvae of Sebastodes goodei, S. paucispinis, S. jordani, and S. saxicola with distinguishing characteristics between Sebastodes, Scorpaena, and Oligocottus.

877. McCammon, George W. 1956. A TAGGING EXPERIMENT WITH CHANNEL CATFISH (ICTALURUS PUNCTATUS) IN THE LOWER COLORADO RIVER. Calif. Fish and Game, Vol. 42, No. 4, Oct., pp. 323-335.

The sport fishery for channel catfish in the lower Colorado River is a resource that is vitally important to California's anglers. However, information necessary to manage the fishery is lacking. In 1953, an exploratory tagging study was begun to provide preliminary data on trapping and tagging techniques, annual rate of harvest, and migrations of channel catfish. The fish were trapped and tagged between Parker and Imperial dams. Trapping

during the winter months yielded very few fish, while spring trapping was fairly productive when fyke nets were fished immediately below sand bars.

A total of 264 channel catfish was tagged, 164 with disk-dangler tags and 100 with hydrostatic tags. Anglers reported recovery of 53 tags (20 percent) during the first 12 months. Twenty-one percent of the hydrostatic tags and 19.5 percent of the disk-dangler tags were returned. The difference is not statistically significant; however, it is believed that the nearly equal rates of return failed to reflect certain fundamental differences in the effectiveness of the tags. Shedding of hydrostatic tags was probably offset by more complete reports of recoveries of that tag than of disk-danglers. The return of disk-dangler tags was estimated to be only 85 percent complete. Statistical procedures demonstrated that tag returns were apparently independent of both the size and sex of the fish.

Data on the movement of tagged fish indicated a definite tendency for channel catfish to move downstream from the Palo Verde Weir during the fall months. This movement may be partial evidence of a regular, seasonal migration. The Palo Verde Weir is, apparently, an efficient barrier to the upstream movement of channel catfish. The return of 20 percent of the tags in the first year indicates that the fishery is not overexploited; however, a larger number of fish will have to be tagged before accurate information on both the annual rate of harvest and migration can be obtained. (A)

878. Mekjian, Harry M. and Jack W. Schott. 1956. A SIMPLE OPTIC BENCH FOR SCALE PHOTOMICROGRAPHY. Calif. Fish and Game, Vol. 42, No. 4, Oct., pp. 347-349.

Design and equipment needed for a compact, easily portable, simple and efficient optic bench for scale photography is described.

879. Herald, Earl S. 1956. CONDITIONED SPACE RESPONSE IN AN AQUARIUM TANK BY THE CALIFORNIA YELLOWTAIL, SERIOLA DORSALIS. Calif. Fish and Game, Vol. 42, No. 4, Oct., pp. 351-352.

Eleven yellowtail after spending two years in a 1400 gallon tank were transferred to a tank of almost double this capacity, but having the same orientation. The fish made little or no use of the additional space for almost 2 months confining their swimming to one section. It took 3 to 4 months for them to utilize the additional space to a moderate degree, and 5 to 6 months before this preference for one-half the tank became unnoticeable.

880. Kimsey, J. B. 1956. LARGEMOUTH BASS TAGGING. Calif. Fish and Game, Vol. 42, No. 4, Oct., pp. 337-346.

Six different kinds of tags were tested in the aquarium and in the field. Although observations were limited in some instances, they supported the following conclusions.

Strap tags used on various parts of the mouth do not yield adequate mortality data because of their rapid shedding, apparently caused by rapid growth. In yearling fish, a tag large enough to allow for growth is too cumbersome and a smaller tag is shed too rapidly. Twenty of 50 round-jaw tags, similar to bird bands, fastened over the premaxillary and maxillary bones were shed in 30 days.

Peterson disc tags placed loose enough for growth move enough to cause bad sores. If growth is normal, they are shed too quickly. Two-wire staple tags become stable only if the disc turns over, which in effect makes it a disk-dangler tag. The wires are exposed to excessive abrasion when this occurs. Formation of a severe sore preceeded the tag turn-over. Two-wire disk-dangler tags are long lasting and none has been shed. A change in the shape of the wire frame from rectangular to triangular is indicated.

Plastic "spaghetti" tags were not shed in the aquarium, nor have they caused sores. The possibility of their catching on brush has not been tested adequately and a fastening improvement may be needed.

Einar Lea hydrostatic tags tend to cut out or change position and catch on nets and vegetation due to the hard, small-diameter, stainless steel wire bridle. They are not satisfactory unless this bridle design is changed. (A)

881. McCully, Howard. 1956. AN UNDESCRIBED TYPE OF MIGRATION IN KING SALMON, ONCORHYNCHUS TSHAWTYTSCHA (WALBAUM). Calif. Fish and Game, Vol. 42, No. 3, July, pp. 189-198.

From 1950 to 1953 many of the smaller adult king salmon in the Sacramento River during August and September returned downstream to brackish water, 80 miles or more. As many as one out of four fish present at Fremont Weir between September 9 and September 15 may have made this journey. This downstream movement occurred from August 1 to December 10 or longer. Most of those that went down must have gone back up the Sacramento River to spawn in the late fall and winter. One tagged salmon returned to the Pacific Ocean and stayed there until its capture the following May. It is not unreasonable to suppose that other individuals have made similar movements. (A)

882. Gibbs, Earl D. 1956. A BISEXUAL STEELHEAD. Calif. Fish and Game, Vol. 42, No. 3, July, pp. 229-231.

An adult sea-run steelhead rainbow trout having both male and female reproductive organs was caught in the South Fork of the Eel River, near the town of Garberville, Humbolt County, California, on January 7, 1955. It weighed 8 pounds and had the superficial appearance of a male. Citations are given for published records of bisexual silver salmon, a hermaphroditic cutthroat trout, and a bisexual king salmon.

883. Ehlers, Robert. 1956. AN EVALUATION OF STREAM IMPROVEMENT DEVICES CONSTRUCTED EIGHTEEN YEARS AGO. Calif. Fish and Game, Vol. 42, No. 3, July, pp. 203-217.

An evaluation of stream improvement devices on the East Fork of the Kaweah River was made in

1953. Ten out of a total of 41 improvement structures installed by the United States Forest Service in 1935 remained in operation after 18 years of service. Only log structures were intact, while rock, masonry, earth, and crib dams had washed out. Nine additional structures were still present in 1953, but were either nonfunctioning or had been damaged to the extent that they were of minor value.

Fifteen pools have resulted from the original 41 improvements. This includes 9 pools below the structures, 3 pools above, and 3 pools continuous above and below. Most pools formed above have tended to fill in, while those below remain more or less constant in depth, depending on stream volume and velocity.

From all indications, the failures resulted from the endcutting and undercutting action of water on the loose bottom and bank materials. Rock, earth, and masonry dams are especially susceptible to flood damage. Log structures, on the other hand, hold very well providing they are adequately anchored. A lack of large rock in the area for suitable anchoring material seems responsible for the loss of many structures.

Willows and other rooted vegetation were present in most cases at the extremities of the remaining operating structures. In those cases where vegetation was not present, the improvements were either heavily anchored with large rock, built 5 to 6 feet into the bank, or had a combination of these two features. (A)

884. Burrows, Roger E. and David D. Palmer. 1955. A VERTICAL EGG AND FRY INCUBATOR. The Prog. Fish-Cult., Vol. 17, No. 4, Oct., pp. 147-155.

A vertical incubator for salmon eggs and fry has been designed, constructed, and tested under hatchery production conditions. The incubator has proved entirely practicable and may be adapted to meet specific requirements. The most efficient of conventional equipment requires four times the floor space and at least four time the water supply of the vertical incubator. Undoubtedly, this equipment could also be used for trout, particularly those species that have large eggs. Diagrams of construction details are presented. (A)

885. Bradford, Arthur D. and Thomas Iezzi. 1955. TRACING THE COURSE OF HATCHERY GROUND WATER SUPPLIES WITH AN IMPROVED FLUORESCEIN CONCENTRATION METHOD. The Prog. Fish-Cult., Vol. 17, No. 4, Oct., pp. 156-160.

The method described permits detection of fluorescein in concentrations of 1 part in 20 billion; experienced observers can detect even much smaller amounts. Briefly, the test consists of adding acid to a water sample to render the dye less soluble, extracting with an organic solvent that is not soluble in water, separating the solvent layer from the water into a test tube, and rendering it alkaline with sodium hydroxide. The small amount of water added in rendering the solvent layer alkaline assumes the characteristic green color under natural light at concentrations as low as 0.0005 ppm. or the color can be detected in smaller concentrations with the aid of a focusing carbon-arc lamp. The great sensitivity of this method requires extreme precautionary measures in handling the dye and running the test. Persons handling the dye should in no way be connected with water sample collection and analysis. The uses of fluorescein in tracing underground or surface water flows and currents are innumerable; pollution source detection would be a profitable use. Details of the detection method are presented.

886. Johnson, H. E. 1955. DURATION OF TOXICITY OF MALATHION. The Prog. Fish-Cult., Vol. 17, No. 4, Oct., p. 161.

Concentrations of 0.32, 0.24, and 0.18 ppm. of Malathion 500 were tested. Nineteen of 20 chinook salmon fingerlings were dead within 24 hours in water which had a concentration of 0.32 ppm. 14 days earlier. Similarly, the 0.18 ppm. concentration which was fatal to 14 of 20 fingerlings in a 48-hour exposure was fatal to the same number out of 20 introduced on the 14th day after the Malathion had been added. Use of Malathion 500 as a substitute for rotenone is being studied.

887. Saila, Saul B. 1955. T-0_2, AN INSTRUMENT FOR THE ESTIMATION OF TEMPERATURE AND DISSOLVED OXYGEN IN NATURAL WATERS. The Prog. Fish-Cult., Vol. 17, No. 4, Oct., pp. 162-165.

The instrument described which combines a simple thermistor circuit with an electrolytic cell in a single unit has been used for field estimation of the vertical distribution of temperature and dissolved oxygen. Calibration of temperature-corrected current readings is accomplished by analyzing two or three water samples for dissolved oxygen by conventional chemical methods. However, no calibration seems needed for rough-and-ready classification of standing waters into trout and non-trout habitat. Fishery workers may construct similar equipment at moderate cost.

888. Wood, E. M. and W. T. Yasutake. 1955. HISTOPATHOLOGY OF FISH I. TECHNIQUES AND PRINCIPLES. The Prog. Fish-Cult., Vol. 17, No. 4, Oct., pp. 166-171.

The preparation of tissues for observation under a microscope is described in detail. Illustrative photographs are included.

889. Wright, James E. 1955. CHROMOSOME NUMBERS IN TROUT. The Prog. Fish-Cult., Vol. 17, No. 4, Oct., pp. 172-175.

Young embryos of brook, brown, and rainbow trout taken from hatchery trays after 2 to 9 days of incubation at 50° F. were used. Optimum results were obtained with 3 to 4-day-old embryos. Fixation and slide preparation are described.

The somatic chromosome numbers of brook trout and brown trout were determined to be 84 and 80, respectively. This conforms with earlier work done by Svardson. Chromosome morphology in the two species appears to be quite similar. The

somatic chromosome number in rainbow trout was determined to be 60. This explains the ease of hybridizing brown and brook trout and the extreme difficulty encountered in crossing rainbow trout with brown trout and brook trout. On the basis of both chromosome-number relationships and ability to hybridize, the species belonging to different genera are more closely related than the two placed in the same genus.

The explanation of sterile hybrids from a brown-brook trout cross probably rests with minor differences between the two complements of chromosomes, but from this study it seems that some functional eggs or sperm might be expected. It would also seem from information now available that an Atlantic salmon-rainbow trout cross might produce fertile hybrids since their chromosome number (60) is the same and chromosome morphology is similar.

890. Skinner, J. E. 1955. A DEFOAMER USED TO PREVENT FOAMING IN FISH TRANSPORT TANKS. The Prog. Fish-Cult., Vol. 17, No. 4, Oct., p. 176.

Dow Corning Antifoam AF Emulsion proved very satisfactory in preventing or eliminating foam and scum formation in tanks to which sodium amytal or methyl pentynol had been added. Twenty-five c.c. of the latter, an especially heavy foamer, and 200 pounds of trout were placed in 100 gallons of water to create a good formation of scum and foam. Addition of 25 c.c. of a 10 percent dilution of the antifoam emulsion completely eliminated the foam and left but a thin film of scum within one minute. No toxic effects on fish were observed. Elimination of foaming should permit retention of an effective concentration of drug by preventing its usual loss through foaming.

891. Adelman, Harvey M. and Joseph L. Bingham. 1955. WINTER SURVIVAL OF HATCHERY-REARED AND NATIVE BROOK TROUT. The Prog. Fish-Cult., Vol. 17, No. 4, Oct., pp. 177-180.

The procedure followed in this study was to plant hatchery-raised and native brook trout into two streams with screened-off areas so that the fish could not radically change their location. Monthly population determinations were made by utilization of a direct-current shocker. In this manner relative survival rates could be determined for 30-day periods thereby highlighting any forthcoming split in survival rates.

Widely disparate results were obtained. These support one main conclusion that survival studied in controlled areas with monthly population determinations produced no evidence supporting increased rates of survival as a function of origin of the fish.

892. Greene, A. F. C. 1955. THE EVOLUTION OF A REARING PROGRAM IN WYOMING. The Prog. Fish-Cult., Vol. 17, No. 4, Oct., pp. 181-185.

Inadequacy of hatchery facilities to raise large numbers of trout to a planting size of 6 inches or larger led to a program of utilizing natural ponds and farm ponds. Though standards for acceptable ponds were established to insure satisfactory control, ease of operation, and good production, the program failed to be a practical solution to the problem. The location of the ponds in widely separated areas precluded definite control and was determined to be the cause for most of the trouble.

Three rearing stations have since been put in operation. These have exceeded expectations in survival, exceeding 85 percent over a year, and production because of the practicality of artificial feeding. Only 4 of the original 136 outlying ponds are now being used and these are close enough to hatcheries to be included as part of their normal operations.

893. Carlander, Kenneth D. and Richard Ridenhour. 1955. DISPERSAL OF STOCKED NORTHERN PIKE IN CLEAR LAKE, IOWA. The Prog. Fish-Cult., Vol. 17, No. 4, Oct., pp. 186-189.

Clear Lake has an area of 3,643 acres and a maximum depth of approximately 20 feet. Of 15,192 young pike, mostly 10.5 to 16.0 inches total length, stocked in the lake in October 1953, 2,630 or 17 percent were tagged. Capture locations of 651 of 780 tagged fish caught by anglers in 1954 were recorded to compare returns from the 7 release points around the lake.

The results of this experiment indicate that stocked northern pike move to all parts of Clear Lake within 6 months, even if stocked at one end. Although the movement is extensive and general, there is evidence that fish stocked in some areas do not get to areas at the other end of the lake in quite the same abundance. A longer period of time between stocking and capture of fish might eliminate even this slight difference in their distribution.

894. Pycha, Richard L. 1955. A QUICK METHOD OF PREPARING PERMANENT FIN-RAY AND SPINE SECTIONS. The Prog. Fish-Cult., Vol. 17, No. 4, Oct., p. 192.

Sections of dry fin rays of sturgeon or pectoral spines of catfish, 1 millemeter or less in thickness, are cut with a jeweler's handsaw and polished on one side with No. 180 silicon carbide paper. The polished side is then imbedded in a cellulose acetate slide with a drop of nitrocellulose cement. The slide is inverted on the carbide paper and ground and polished to the proper thickness for viewing. No cover slip need be added for storage. With practice, one man can complete about 10 slides per hour with 2 sections per slide.

895. Post, George. 1955. A SIMPLE CHEMICAL TEST FOR ROTENONE IN WATER. The Prog. Fish-Cult., Vol. 17, No. 4, Oct., pp. 190-191.

A color test has been developed to provide a quantitative estimate of rotenone in water. The method has been found satisfactory to determine the amount of rotenone, either in the form of Noxfish, Chem-fish, or powdered Cube, in water having total solids up to 35,000 ppm. The method described is based on a qualitative test devised by Jones and Smith (1933) and later improved by Rogers and Calamari (1936). Though not sufficiently

accurate for strict quantitative work, the use of an improvised color chart prepared from colors produced by known concentrations of chemically pure rotenone yields a fair estimate of the amount of rotenone present in a water sample. This test may replace the use of live fish in many instances.

896. Mullan, James W. 1956. THE COMPARATIVE RETURNS OF VARIOUS SIZES OF TROUT STOCKED IN MASSACHUSETTS STREAMS. The Prog. Fish-Cult., Vol. 18, No. 1, Jan., pp. 35-38.

Percentage of returns, i.e. actual tag recoveries in hand, by stocking sizes, for 62,680 tagged brook, brown, and rainbow trout stocked in 5 typical, major stream drainages during the month of March over the last 3 years, shows a significantly greater return for the larger fish as compared to the smaller fish planted. Yearling 6- to 8-inch fish gave the poorest return, 9- to 12-inch 2-year-olds gave the highest return, 8- to 9-inch yearlings or 2-year-olds gave returns between these aforementioned categories, and 12-inch-plus brood stock provided returns comparable to those of 9- to 12-inch fish. Valid comparison requires the deletion of the last category, as it represents discarded brood stock; they represent the frosting of the annual total hatchery output and cannot be produced economically for stocking purposes even though much in demand by the angler.

Attention is focused on the fact that all these recoveries represent actual tags recovered. No corrections for tag non-respondence are included in the data presented. Marked differences in the tag-recovery levels between drainages are attributed to the use of tag-return boxes which greatly facilitated sportsmen's cooperation in returning tags on the Millers, Ipswich, and Merrimac drainages, and to inherent differences in runoff, angling pressure, watersheds, and year studied between drainage systems. Therefore, valid comparison is possible only between species and size in a particular drainage and not between drainages, even though the premise of differential recovery due to size is apparent.

Although minor discrepancies exist, the average increment of return between 6- to 8-inch trout and trout more than 8 inches in length approximates 50 percent (21 percent actual return for 6- to 8-inch trout, 31 percent for trout above this size).

It is concluded that by cutting the numerical stocking rates by one-third and stocking a similar poundage of 8-inch-plus fish, the same numbers of trout could be harvested by the angler, but the creel weight would be increased by 33 percent. This is predicated in terms of yearlings only and would necessitate artificial inducement of early spawning by light manipulation and the holding of the groups of smaller fish for in-season stocking at larger sizes. These procedures would reduce the mortalities produced by stocking smaller trout during that period of high water which normally precedes the trout season in Massachusetts.

897. Adelman, Harvey M. and Joseph L. Bingham. 1956. SIZE DISCRIMINATION IN THE BROOK, BROWN, AND RAINBOW TROUT. The Prog. Fish-Cult., Vol. 18, No. 1, Jan., pp. 26-29.

A 16 by 9 by 11-inch deep discrimination box with two 5- by 3-inch windows at one end was suspended in a large aquarium. Test trout, eight of each species, were conditioned to push out these windows under threat of noxious stimulation, i.e. tapping on the tail with a stick. The tests consisted of discrimination between 0.75-inch and 0.50-inch diameter circles in the first series and 0.50-inch and 0.25-inch diameter circles in the second series painted on the windows. In both series, escape from the box could be effected only by pushing out the window with the smaller circle. Avoidance rather than approach conditions were chosen for this experiment as it was believed that feeding might produce sluggishness that might interfere with subsequent learning. Each subject had to swim directly to the smaller circle 10 successive times before learning was considered complete.

In the first series, brown trout reached this criterion in 18 trials, rainbow in 29.5, and brook in 32.8. The difference between the brook and brown trout was significant beyond the 0.001 level of confidence; the other comparisons revealed no significance. In the second series brown trout again averaged 18 trials, whereas rainbow and brook trout took 16.6 and 50.3 trials. The difference between brown and brook trout was significant beyond the 0.01 level and that between rainbow and brook beyond the 0.001 level. That brown and rainbow trout were able to make sensory perceptions more readily than brook trout is apparent. Furthermore, the effect of learning one discrimination upon the speed of learning a second was so disparate as to indicate that it is more a function of the species than the operation of a systematic variable for trout in general. The results seem to support the common observation that brown and rainbow trout are more "intelligent" than brook trout.

898. Shields, J. T. 1956. MARKERS FOR BRUSH SHELTERS. The Prog. Fish-Cult., Vol. 18, No. 1, Jan., p. 29.

Fifteen-gallon grease drums filled with seven $2\frac{1}{2}$ by 12 by 4-inch blocks of styrofoam made virtually unsinkable buoy markers for brush shelters. Cost of styrofoam for each barrel amounted to less than $3.00 retail.

899. Hardjono, Atmo. 1956. THE INLAND FISHERIES OF INDONESIA. The Prog. Fish-Cult., Vol. 18, No. 1, Jan., pp. 30-34.

This article describes culture of Chanos in brackish-water ponds, of carp and Tilapia in combination with rice cultivation, and of Chanos and a cyprinid in irrigation reservoirs. Management of the fisheries of marshes or swamps, lakes, and rivers is briefly discussed.

900. Warner, George H. 1956. REPORT ON THE AIR-JET FISH-DEFLECTOR TESTS. The Prog. Fish-Cult., Vol. 18, No. 1, Jan., pp. 39-41.

This device, a combination bubble and noise making contrivance, failed to divert young salmon. Its construction and study findings are discussed.

901. Anonymous. 1956. POPULATION CHANGES AND STUDIES CAUSED BY THE SEA LAMPREY. The Prog. Fish-Cult., Vol. 18, No. 1, Jan., p. 41.

In Lake Michigan in 1955 more than 1,000 miles of gill nets set at various depths throughout the lake captured only 8 lake trout whereas under average conditions before the lamprey invasion the same effort would have taken more than 57,000 lake trout. Other populations have also been affected. The bloater, a small cisco once the major food of lake trout, has increased 300 percent. Members of a larger species of cisco, however, have declined 27 percent, with the threat of further depletion by lamprey.

Preliminary findings of studies concerned with eventual reestablishment of lake trout in Lakes Huron and Michigan have overwhelmingly favored spring stocking of lake trout over fall stocking. Additional studies are being conducted to determine the optimum depths of water for planting and the size of trout needed to insure good survival.

902. Usinger, Robert L. and Paul R. Needham. 1956. A DRAG-TYPE RIFFLE-BOTTOM SAMPLER. The Prog. Fish-Cult., Vol. 18, No. 1, Jan., pp. 42-44.

This sampler can operate at depths greater than an arm's length thereby removing the most serious objection to devices similar to the Surber sampler. Preliminary tests indicate that the drag-type will, when pulled over 10 feet of bottom, take organisms in numbers and proportions roughly similar to those taken by the Surber bottom. Its design, technique of use, and limitations are described.

903. Hendricks, Lawrence J. 1956. GROWTH OF THE SMALLMOUTH BUFFALO IN CARP PONDS. The Prog. Fish-Cult., Vol. 18, No. 1, Jan., pp. 45-46.

Two ponds containing largemouth bass and bluegill were stocked with a carp and buffalo combination. Removal of fish populations approximately one year later revealed that buffalo had gained in average weight while carp lost. A number of variables involved in this study which limit validity of conclusions are discussed.

904. Greene, A. F. C. 1956. OXYGEN EQUIPMENT FOR FISH TRANSPORTATION. The Prog. Fish-Cult., Vol. 18, No. 1, Jan., pp. 47-48.

A large-size aquarium-type aerator is described, its main components consisting of a carbon rod 4 feet long and 6 inches in diameter to which and through which oxygen is fed under pressure.

905. Sneed, Kermit E. and Howard P. Clemens. 1956. SURVIVAL OF FISH SPERM AFTER FREEZING AND STORAGE AT LOW TEMPERATURES. The Prog. Fish-Cult., Vol. 18, No. 3, July, pp. 99-103.

Normal frog Ringer's solution was isotonic to sperm from out-of-season carp and goldfish, and it maintained sperm inactivity. A few sperm were capable of motility after storage in these solutions at 5° C. for 30 days. It was necessary to add 200 to 500 milligrams of potassium chloride to normal frog Ringer's to produce immotility in sperm from ripe fish, whether the ripening process was accelerated by temperature or by injections of dried pituitaries.

Carp milt diluted with isotonic Ringer's plus 6 to 12 percent glycerin, frozen, and stored at a temperature of −73° C. for 60 hours contained 20 percent motile sperm when thawed. Complete survival of frozen sperm and storage for long periods probably depend upon perfection of diluters. While there is no evidence that frozen fish sperm will fertilize eggs, the possibility is suggested by the literature on other animals, notably cattle and man. (A)

906. Schneidermeyer, Frank and William M. Lewis. 1956. UTILIZATION OF GIZZARD SHAD BY LARGEMOUTH BASS. The Prog. Fish-Cult., Vol. 18, No. 3, July, pp. 137-138.

Gastroscopic analysis of the stomach contents of 211 largemouth bass taken during the spring and summer of 1955 revealed that, of the 107 stomachs containing food, 85 contained gizzard shad. Items of less frequent occurrence included crayfish, turtle, algae, and miscellaneous fishes. Analysis of the scales of this bass population subsisting primarily on gizzard shad indicated that the rate of growth of the population was above the average.

It was concluded that the gizzard shad is a desirable fish where management is directed toward production of largemouth bass. (A)

907. Phillips, Arthur M., Jr., Donald R. Brockway, and George C. Balzer, Jr. 1956. THE CHEMISTRY OF DEVELOPING BROWN TROUT EGGS. The Prog. Fish-Cult., Vol. 18, No. 3, July, pp. 104-107.

To determine chemical changes occurring in brown trout eggs during incubation, samples were taken from a single lot of eggs from the time of water-hardening through hatching. The percent of water in the egg decreased to the end of the fifth week and thereafter increased rapidly. The percent of protein increased for 3 weeks, then decreased throughout the remainder of the incubation period. The ash content remained constant throughout incubation. The percent of fat decreased for 4 weeks and then increased throughout the remainder of incubation. The iodine number of the fat of the eggs did not change. The wet weight of the eggs decreased for 3 weeks and then remained constant. After hatching, the fry showed a marked increase in wet weight. (A)

908. Wood, E. M. and W. T. Yasutake. 1956. HISTOPATHOLOGY OF FISH: IV. A granuloma of brook trout. Prog. Fish-Cult., Vol. 18, No. 3, July, pp. 108-112.

A granulomatous lesion has been observed in

the visceral organs of brook trout from hatcheries scattered throughout the United States. A mycosis-like structure is associated with the lesions, but attempts to culture it have been unsuccessful. The disease is apparently identical to a condition previously described as a neurilemmoma, but the true etiology remains totally unknown. (A)

909. Phillips, Arthur M., Jr. 1956. THE NUTRITION OF TROUT. I. General Feeding Methods. Prog. Fish-Cult., Vol. 18, No. 3, July, pp. 113-119.

A general discussion of the factors affecting the efficiency of a fish-hatchery feeding program, including consistency of the diet, types of feed mixtures, amounts fed, effect of water temperature, storage of food mixtures, quality of food products, frequency of feeding, food preparation, feeding practices, and special feeding conditions. (A)

910. Pechacek, Louis S. 1956. THE EFFECTS OF TAGS ON THE RATE OF GROWTH AND CONDITION OF SEVERAL SPECIES OF COLD-WATER FISH IN WYOMING. The Prog. Fish-Cult., Vol. 18, No. 3, July, pp. 120-125.

This study is based on 216 tagged fish recaptured 1 to 3 times each for a total of 274 recoveries. Of the 216 fish, 115 were brown trout, 95 were rainbow trout, 4 were whitefish, and 2 were cutthroat trout, all taken from 1 lake and 4 streams. Three different types of tags, attached on 5 different positions are represented. Eighty percent of the recoveries consisted of the band and the strap tag attached to the jaw. All fish were wild stock, 85 percent were 8 inches or longer at time of tagging, and practically all were in their third year of life or older.

On comparing the average growth or increment of the tagged fish for any period of time with the average increment for untagged fish from the same body of water for a like period of time, it is apparent that the tagged fish do not maintain their natural growth rate. The effects on growth are more apparent than the effects on condition. Still more obvious is the tendency for most fish to lose weight or to fail to gain in some stage of their growing period after tagging. For most fish, this static period occurs immediately after tagging and is followed by what appears to be a retarded growth rate. Other fish, which have previously had a good growth rate, have this rate gradually decline after tagging until it is very retarded. Those fish which start very slowly seem to progress at a very consistent rate even though retarded.

Of 218 trout recoveries with an average coefficient of condition of 38.4314 at time of tagging, 63.76 percent showed a decrease in C factor of 5.127 while the other 36.25 percent showed a gain of 3.387.

911. Westman, James R. and Joseph V. Hunter. 1956. PRELIMINARY OBSERVATIONS ON THE LOWERING OF DISSOLVED OXYGEN BY SODIUM SULFITE AND ITS EFFECTS ON CERTAIN FISHES, WITH PARTICULAR REFERENCE TO PROBLEMS IN FISH MANAGEMENT. The Prog. Fish-Cult., Vol. 18, No. 3, July, pp. 126-130.

The use of sodium sulfite in salvaging and thinning fish populations was studied under laboratory conditions and in one small farm pond. In contrast to other methods, it is apparently nontoxic and its speed and degree of action can be controlled to desired limits. Due to cost, about 10 cents a pound, its use seems restricted to small lakes and ponds.

Data are presented showing the relation of concentration and temperature on the time between application and onset of effects and on the length of the period during which fish surfaced and could be captured. Applied to a small farm pond to provide a concentration of 168 ppm., golden shiners surfaced in 15 minutes, followed within minutes by largemouth bass, catfish, chub-suckers, carp, goldfish, and common sunfish. All fish salvaged, which included at least one adult of each species, revived within 5 minutes after being placed in containers with running water. All fishes with inferior mouths, carp, goldfish, and suckers, appeared to suffer 100 percent mortality while the other species presumably able to withstand the low oxygen concentration by gulping at the surface did not suffer such heavy mortality.

912. Wood, E. M. 1956. URETHANE AS A CARCINOGEN. The Prog. Fish-Cult., Vol. 18, No. 3, July, pp. 135-136.

Urethane has produced lung tumors in mice, rats, and rabbits when injected, added to drinking water, instilled nasally, or painted on the skin. No urethane-induced lung tumors in humans are known; however, it is known to cause leucopenia in humans and therefore is used in the treatment of leukemia. It has also been demonstrated that though urethane is not itself carcinogenic for mouse skin, it is able to induce the initiating phases of carcinogenesis in skin.

Little is known about the absorption of urethane from a water solution. Until more is known, however, concern for the health of an individual who has prolonged contact with such solutions seems paramount.

(Dr. W. C. R. Hueter of the National Cancer Institute recommends that anyone who works with urethane should do so with utmost caution, protecting skin from contact with the solution and wearing respirators during preparation of the solution, even though there is no medical evidence that urethane is carcinogenic to man. R. T. Webb, Fish and Wildlife Service, Atlanta, Georgia, reports the successful use of a substitute, M.S. 222, tricaine methanesulfonate, as an anesthetic and aid in fish distribution. Editors, Prog. Fish-Cult.)

913. Allin, Roger W. 1956. USE OF LIGHT AIRCRAFT IN LAKE-SURVEY ACTIVITIES. The Prog. Fish-Cult., Vol. 18, No. 3, July, pp. 139-140.

A 4-place light aircraft equipped with pontoons was used in general reconnaissance, depth sound-

ing, water sampling, and gill net setting. Plane adaptations are described.

914. Tanner, R. P., Harold Newman, and R. W. Sharp. 1956. MALACHITE GREEN AND GENTIAN VIOLET COMPARED AS TREATMENTS FOR RAINBOW TROUT EGGS. The Prog. Fish-Cult., Vol. 18, No. 3, July, p. 140.

Malachite green exhibited a general superiority over gentian violet in experiments to control soft-egg disease of rainbow trout eggs. Control of this disease by use of either dye was not demonstrated, however, owing to the general absence of this condition during the period of study.

915. Hagen, Harold K. 1956. AN INEXPENSIVE SCALE PROJECTOR. The Prog. Fish-Cult., Vol. 18, No. 3, July, pp. 141-142.

Modification of a slide projector by adding a Micro-Beam projection unit is described. This unit, manufactured by S. V. E. Company of Chicago, Illinois, magnifies 12 times for each foot of projection. It is inexpensive and, being pocket size, readily portable.

916. Gangmark, Harold A. and Robert D. Broad. 1956. AN EXPERIMENT WITH VIBERT BOXES. The Prog. Fish-Cult., Vol. 18, No. 3, July, pp. 143-144.

Plastic sacks and Vibert boxes were tested under comparable conditions to determine the extent of additional protection afforded eggs by the boxes. It had been supposed that the extremely rigid plastic boxes would eliminate losses caused by the grinding wearing action of stream erosion, but except for three sack samples washed downstream, the sacks gave a higher average percent of egg survival.

917. Hublou, Wallace F., Thomas B. McKee, Ernest R. Jeffries, Russell O. Sinnhuber, and Duncan K. Law. 1955. FIFTH PROGRESS REPORT ON SALMON DIET EXPERIMENTS. Res. Brief of the Fish Comm. of Oreg., Vol. 6, No. 2, Dec., pp. 10-14.

Ten diets, 7 with 10 percent beef liver and the other 3 with a larger proportion of beef liver, were tested on fingerling spring chinook salmon. Other diet components were turbot, hake, and shad in the round; rockfish fillet scrap without livers; commercial chinook salmon meal; a meal mixture; and yellowfin tuna viscera without livers. Terramycin (Bi-Con TM-5) was added to a diet identical with an all-meat control diet. Further experimentation with turbot, hake, salmon meal, and tuna viscera seems desirable since these showed promise. The problem of anemia, a condition exhibited by all fish fed the seven 10-percent liver diets, needs further study. Results are tabulated and pictured graphically.

918. Pulford, Earl F. 1955. ESCAPEMENT OF SPRING CHINOOK SALMON AND STEELHEAD OVER WILLAMETTE FALLS IN 1954. Res. Briefs of the Fish Comm. of Oreg., Vol. 6, No. 2, Dec., pp. 21-24.

The 1954 Willamette Falls fishway escapement of spring chinook salmon was estimated to be approximately 31,100 including 29,300 adults and 1,800 jacks. For the third consecutive year the spring chinook salmon progeny escapement surpassed the parent escapement, based on a 5-year cycle. The largest steelhead count in 9 years of counting was made in 1954, amounting to 5,197 fish after inclusion of the rest period correction factor.

The bulk of the salmon migration occurred from April 28 to May 13. A correction factor of 31.6 percent of the preceding afternoon's counts was used to calculate the night migration.

919. Henry, Kenneth A. 1955. RIVER RECOVERIES OF MARKED SILVER SALMON OF THE 1949 BROOD RELEASED FROM THE NEHALEM RIVER HATCHERY. Res. Briefs of the Fish Comm. of Oreg., Vol. 6, No. 2, Dec., pp. 25-31.

A total of 104,194 marked silver salmon of the 1949 brood was liberated at the Foley Creek Hatchery on the Nehalem River on March 13, 1951. The first marked fish was taken in the Nehalem River commercial fishery the first week in September 1952, and the peak catch of marked fish occurred about the time of the closure of the fishing season—October 14. On Tillamook Bay the first recorded capture of a marked fish was during the week ending September 27, 1952, and most of the captures occurred during the time the fishery was closed on the Nehalem River. The first marked adult fish was recovered at the hatchery racks on December 3 and the majority appeared to arrive the following week.

Lower and upper limits on a population estimate for the 1952-53 silver salmon run in the Nehalem River were 44,727 and 111,032 based on a single combined commercial catch sample, or 44,727 and 109,049 based on the 2-week catch samples.

Lower and upper limits on the Nehalem River commercial fishing intensity, based on recovery of marked fish only, were 27 and 40 percent based on a single combined sample or 27 and 39 percent on 2-week samples. Based on actual catch and the calculated population limits, these limits were 21 and 53 percent. These are maximum figures inasmuch as any unobserved marked fish at the hatchery or on the spawning grounds would reduce the calculated intensity. (A)

920. Wood, James W. and Joe Wallis. 1955. KIDNEY DISEASE IN ADULT CHINOOK SALMON AND ITS TRANSMISSION BY FEEDING TO YOUNG CHINOOK SALMON. Res. Briefs, Fish Comm. of Oreg., Vol. 6, No. 2, Dec., pp. 32-40.

Kidney disease was found in adult spring chinook salmon in the Middle Willamette River in 1954 and 1955, and an extensive examination in 1955 revealed that 4.3 percent of the chinook handled at the Dexter Dam holding ponds were infected. Although infected fish exhibited a higher mortality than non-infected fish, kidney disease in 1955 was

not a major cause of mortality among spring chinook salmon awaiting maturation in these holding ponds.

Kidney disease was found to be transmissible to young salmon by feeding as evidenced by the fact that the infected flesh and viscera of adult spring chinook salmon, when fed in the diet of young spring chinook for a 41- to 52-day period, transmitted the disease to 100 percent of the fingerlings. A low level of sulfamethazine, 2 grams per 100 pounds of fish, evidently blocked the transmission of kidney disease to young spring chinook when fed in a diet containing the flesh and viscera of infected adult spring chinook salmon.

921. Ayers, John C. 1956. A DYNAMIC HEIGHT METHOD FOR THE DETERMINATION OF CURRENTS IN DEEP LAKES. Limnol. and Oceanography, Vol. 1, No. 3, July, pp. 150-161.

An adaptation of the oceanographer's dynamic height method to fresh-water conditions, the method develops directly from the Smithsonian Tables of water density as a function of temperature and from Amagat's coefficients of compressibility. Pressure effects are handled by use of the decibar system. The calculated dynamic heights are plotted and contoured. Current directions are obtained by application of the geostrophic principle; current velocities are computed from the slopes of the surface topography. A table of specific volume anomalies, necessary for the height computation, has been developed. Sources of potential error are reviewed and assessed. The method has been applied to three synoptic surveys of Lake Huron, and the results obtained are both internally consistent and in good agreement with the behaviors of other parameters. When used with proper caution the method appears to be a promising technique for the study of certain circulation phenomena of large deep lakes. (A)

922. Hayne, Don W. and Robert C. Ball. 1956. BENTHIC PRODUCTIVITY AS INFLUENCED BY FISH PREDATION. Limnol. and Oceanography, Vol. 1, No. 3, July, pp. 162-175.

Sampling of benthic organisms was carried out in two similar, 1-acre ponds in southern Michigan throughout the open water period of 1951. The bottom fauna in each pond was sampled by means of 20 Ekman dredge collections each week. This sampling scheme was found capable of detecting a difference between two populations when the ratio of their magnitudes is 1.9. Fish were present in one of the ponds in the first half of the summer. These were then transferred from this pond to the second pond in early July. Rates of growth of the fish and the bottom organisms were estimated and the production calculated at both trophic levels. The apparent rate of change of bottom fauna biomass was assumed to reflect a basic rate of increase varying inversely with the biomass level, minus the rate of fish predation.

Calculated production of 811 pounds of fish-food and 181 pounds of fish are shown to be of reasonable order as compared with other studies, with the fish-food probably underestimated. A factor not included in the calculations was the effect of emergence of aquatic insects. The average production of bottom fauna fish-food during a growing season amounted to about 17 times the standing crop, when fish were present. In the absence of fish, the apparent production rate of fish food decreased and finally stopped at a higher level of standing crop. In the presence of fish, the standing crop of fish food was depressed and the rate of production increased. (A)

923. John, Kenneth R. and Arthur D. Hasler. 1956. OBSERVATIONS ON SOME FACTORS AFFECTING THE HATCHING OF EGGS AND THE SURVIVAL OF YOUNG SHALLOW-WATER CISCO, LEUCICHTHYS ARTEDI LESUEUR, IN LAKE MENDOTA, WISCONSIN. Limnol. and Oceanography, Vol. 1, No. 3, July, pp. 176-194.

Rather suddenly, in the early 1940's, the cisco in Lake Mendota became scarce. The evidence suggested that the decline was caused by heavy summer mortalities in 1940 and 1941, but further study indicated that the summer mortalities had involved mainly older fish and that the primary cause for the decline was a scarcity of young fish in the population at the time of mortalities. Efforts were turned toward a search for the cause of weak year-classes, or year-class fluctuations in general. Experiments were conducted in the laboratory to determine the effects of illumination and of various patterns of incubation temperatures on the date of hatching of the eggs. Eggs exposed continuously to room illumination for 135 to 140 days hatched 7 to 8 days earlier than eggs incubated continuously in darkness. Different values of incubation temperatures acting on the eggs for about one month from the time of fertilization induced the expected proportional rates of development of eggs, but when the eggs were refrigerated at a common temperature after this first month, the rate of development of advanced embryos was retarded while the less developed embryos gained. Under such treatment, eggs incubated at temperatures differing by 1° C. in the range 1° – 6° C., and then incubated for the remainder of the period at a common temperature below 4° C., hatched about one day apart. Eggs incubated from the time of fertilization at a common temperature below 3° C., and then incubated for the last month at higher temperatures differing by 1° C. in the range 1° – 6° C., hatched 7 days apart. Eggs which had developed rapidly toward the hatching stage lay dormant for about 3 months at temperatures below 3° C. They hatched about 4 days earlier than eggs incubated continuously at temperatures below 3° C., having accumulated about 150 degree-days greater exposure. The evidence clearly indicated that the eggs of the cisco in Lake Mendota never hatch under the ice regardless of natural seasonal variations in temperatures and illumination incurred during the incubation period. Moreover, the dates of hatching are probably not affected significantly by any factor except possibly different temperatures incurred after the departure

of the ice from year to year.

Experiments conducted on larval cisco indicated that they require illumination for feeding. They starve if held in darkness with natural densities of food. They begin to swallow water on the first day after hatching as indicated by keeping them in a solution of 2, 3, 5-triphenyltetrazolium chloride. They also begin to swallow particulate materials within the first day. By the third day they began to consume adult Cyclops sp. and by the fifth day better than 90 percent of the larval fish fed on adult Cyclops sp. During the first week, the swimming ability of the food organisms was a decisive factor in the degree of feeding success shown by the larval fish. The test consisted of offering living Cyclops sp. to one group of fish and freshly killed Cyclops sp. to the other group. After the first week, the fish fed equally well on both types of food. The larval fish tolerated about 108-120 degree-days of starvation without harm. Yet, when provided with food they began to feed before the yolk sac was absorbed. The postulations that year-class failures might arise if the eggs hatched under the ice because then the illumination would be insufficient to enable the larval cisco to feed has been disproved. (A)

924. Saila, Saul B. 1956. ESTIMATES OF THE MINIMUM SIZE-LIMIT FOR MAXIMUM YIELD AND PRODUCTION OF CHAIN PICKEREL, ESOX NIGER LESUEUR, IN RHODE ISLAND. Limnol. and Oceanography, Vol. 1, No. 3, July, pp. 195-201.

Mortality rates for chain pickerel were deduced from weighted geometric means of age frequencies in an unexploited and an exploited population. Fishing mortality was considered to be the difference between the two total mortality rates. Calculated growth in length and weight was determined for a composite sample from 32 ponds. Relative yields were computed for six different size-limits and two rates of fishing. It was found that a minimum size-limit of approximately 12 inches (total length) was best. A ratio of production to relative yield was determined, which indicated that less than 39 percent of total production was removed as crop. Management suggestions were made on the basis of these data. (A)

925. Slobodkin, L. Basil and Sumner Richman. 1956. THE EFFECT OF REMOVAL OF FIXED PERCENTAGES OF THE NEWBORN ON SIZE AND VARIABILITY IN POPULATIONS OF DAPHNIA PULICARIA (FORBES). Limnol. and Oceanography, Vol. 1, No. 3, July, pp. 209-237.

Populations of Daphnia pulicaria were maintained under laboratory conditions of constant food supply and temperature. Varying percentages of the newborn were removed from the population at 4-day intervals. Mean size of the residual populations decreased with increasing removal rate, while yield and yield per individual increased. Mean differences between the number of animals present at successive censuses after removal of the newborn decreased with removal rate while mean differences between successive yields increased. The sum of mean differences in residual population and yield was a constant, independent of removal rate. That is, total variability in the population-removal system was not changed by removal rate, although the variability was divided between yield and residual population. The ratio of yield variability to population variability was dependent on removal rate and on the fact that only newborn animals were removed, but was independent of food supply and temperature differences between populations. This ratio also may be independent of the physiological peculiarities of Daphnia. Median life expectancy of the survivors was increased 13-15 days when the removal rate was increased from 25 to 90 percent of the newborn. The median life expectancy with 90 percent removal was 32 to 36 days. (A)

926. Ryther, John H. 1956. THE MEASUREMENT OF PRIMARY PRODUCTION. Limnol. and Oceanography, Vol. 1, No. 2, April, pp. 72-84.

A discussion is presented of the measurement of primary production by short-term experimental methods and by measurement of in situ environmental changes occurring over longer periods of time. The methods described include the measurement of photosynthesis by oxygen production, carbon dioxide assimilation and the associated pH change, and uptake of radioactive carbon (C^{14}). In situ changes in the standing crop and the concentration of inorganic plant nutrients are also discussed, and the possibility explored of relating the rate of uptake of radioactive inorganic tracers to primary production. The relationship between chlorophyll and photosynthesis is reviewed and some new experimental evidence is presented which indicates the possibility of using chlorophyll concentration as an index of primary production. In the discussions of each method emphasis is placed on sensitivity, reliability, and the interpretation of the data. (A)

927. Verduin, Jacob. 1956. PRIMARY PRODUCTION IN LAKES. Limnol. and Oceanography, Vol. 1, No. 2, April, pp. 85-91.

The mean photosynthetic rate of lake phytoplankton under optimal light (natural conditions) is about 0.5 micromoles of 0_2 evolved or $C0_2$ consumed per microliter of organisms per hour; 1-2 micromoles per milligram ash-free dry weight per hour; and 0.2 micromoles per microgram of chlorophyll per hour. Simple equations are presented for computing photosynthetic yield per square meter of water surface. Computations for several lakes yielded values mostly lying between 150-200 millimoles per square meter per day. A year-round study under completely natural conditions in western Lake Erie showed winter yields of about 40 millimoles per square meter per day and summer maxima of about 300. The annual curve followed the solar radiation curve closely. It is estimated that 28 days are required for a gram of phytoplankton (ash-free dry weight) to produce an additional gram of glucose available for repro-

duction; 80 percent of the photosynthate produced is required to support phytoplankton respiration. (A)

928. Penfound, William T. 1956. PRIMARY PRODUCTION OF VASCULAR AQUATIC PLANTS. Limnol. and Oceanography, Vol. 1, No. 2, April, pp. 92-101.

In this paper, data are presented on the productivity of four hay crops, five prairie plots, one floodplain community, one cultivated aquatic crop, two emergent plant populations, and two floating mat communities. The productivity (production rate) of the communities investigated varied with the amount of light, water, and nutrients available. The average productivity, in grams of carbon per square meter per day, based on the terminal crop, was moderate (1.5) in hay crops, tall grass prairie and rice, relatively high (3.6) in giant ragweed and presumably still higher in certain aquatic plants. The terminal standing crop was found to be less than the sum of periodic measurements of the developing crop. It was noted also that the magnitude of productivity values depended upon the time of harvest. The productivity of vascular aquatic plants was usually highest in spring and autumn and lowest during the summer. Low summer productivity was due primarily to the relatively low rate of photosynthesis, compared with that of respiration, during hot summer weather. On the basis of present data it appears that productivity in the terrestrial habitat was greatest along shorelines of water bodies and did not increase continuously in the hydrarch succession toward the regional climax. (A)

929. Hall, Gordon E. 1956. ADDITIONS TO THE FISH FAUNA OF OKLAHOMA WITH A SUMMARY OF INTRODUCED SPECIES. Reprint from the Southwestern Nat., Vol. 1, No. 1, Jan., pp. 16-26.

Report of the collection and distribution in Oklahoma of six fishes not previously recorded from the State (Salmo trutta, Hiodon tergisus, Ictalurus nebulosus, Typhlichthys subterraneus, Fundulus catenatus, Roccus saxatilis) brings the total number of species known from Oklahoma to 167. Three of the six represent introduced forms. A list of all exotic fishes known to be introduced into Oklahoma waters, with the available history of introduction, is included. Of the 14 known or postulated to be introduced, 5 are utilized as bait species and 9 were introduced as additional food for game fishes. Eight have had varying degrees of reproductive success; 5 of the game fishes were not expected to provide reproducing populations, and their success is dependent on continual restocking. Only the introduction of the tench, Tinca tinca, can be considered unsuccessful. (A)

930. Snieszko, S. F. and Philip J. Griffin. 1955. KIDNEY DISEASE IN BROOK TROUT AND ITS TREATMENT. The Prog. Fish-Cult., Vol. 17, No. 1, Jan., pp. 3-13.

Experiments on kidney disease in brook trout were conducted in the hatchery at Berlin, New Hampshire, and in the Microbiological Laboratory at Leetown, West Virginia. Sulfamerazine, sulfanilamide, sulfadiazine, sulfathiazole, Gantrisin, chloramphenicol, terramycin, and aureomycin were tested. Satisfactory control of the disease was obtained with all sulfonamides. Gantrisin and sulfamerazine had the least retarding effect on the growth of brook trout. Factors that may contribute to the spread of this disease are discussed and recommendations for treatment are outlined, in so far as possible, on the basis of the data now available. (A)

931. Shelton, Jack M. 1955. THE HATCHING OF CHINOOK SALMON EGGS UNDER SIMULATED STREAM CONDITIONS. The Prog. Fish-Cult., Vol. 17, No. 1, Jan., pp. 20-35.

Spawning and rearing ponds at the U. S. Fish-Cultural Station on the Little White Salmon River near Cook, Washington, were used to set up artificial gravel beds in which chinook salmon eggs could be planted. The temperature, velocity, and volume of water flowing through the gravel beds were observed and recorded. Plastic screen bags containing salmon eggs were planted in various depths and sizes of gravel. From these bags, removed at periodic intervals, were determined the hatch and mortality of the eggs. Boxes made of wooden frames and plastic screen were also planted in gravel and examined regularly to determine the rate of emergence of fry that hatched from the eggs placed in the boxes.

Controls were set up to determine the efficiency of the plastic bags as retaining agents, the effect of a given type of gravel surrounding the eggs with reference to mortality, and the results from eggs placed in the same type of plastic bag and planted in a natural stream.

The average hatch for the eggs planted under different sets of variables in the gravel was 96 percent. Comparison of these variables reveals that the difference in percentage hatch is insignificant. (It is considered possible that the mortality caused by crushing of eggs could be reduced and the percentage hatch thus increased proportionately.)

The mortality of the planted eggs was divided into two categories: (1) that caused by the crushing of eggs, and (2) that which resulted from unknown causes (primarily percolation).

In the hatchery troughs the total mortality was 2.3 percent, 2.0 percent being caused by the crushing of eggs and 0.3 percent resulting from unknown causes. The eggs planted in Warm Springs River sustained a mortality of 0.5 percent, half of it resulting from unknown causes.

In the gravel beds the mortality due to unknown causes was essentially the same under all the various conditions, as was the percentage hatch under the same conditions.

In the beds of small gravel only 13 percent of all the eggs emerged as fry, but 87 percent emerged in the large-gravel beds. By the time the fry were approximately 92 days old (considered from the date all live eggs in the samples were hatched),

with the exception of 1 box, 50 percent or more of all fry had emerged from the large-gravel beds. The highest percentage emergence from the large-gravel beds was obtained from the eggs planted 6 inches below the surface of the gravel and the eggs planted in the low-velocity pond.

The percolation or movement of water within the gravel ranged from 0.1 to about 0.001 foot per second. This movement progressively increased from the low— to the high-velocity pond. A velocity as low as 0.001 foot per second was evidently satisfactory for the hatching of chinook salmon eggs, and a satisfactory percentage emergence of fry was obtained where the subsurface water velocity was as low as 0.002 foot per second.

Correlation of these velocity measurements with hatching of eggs indicates that chinook salmon eggs will hatch and young fry will emerge from gravel when the water velocity within the gravel is as low as 0.002 foot per second. (A)

932. Slack, Keith V. 1955. AN INJECTION METHOD FOR MARKING CRAYFISH. The Prog. Fish-Cult., Vol. 17, No. 1, Jan., pp. 36-38.

Bates Numbering Machine Ink injected just beneath the shell and to one side of the median ventral nerve cord of the abdomen proved successful by being nontoxic, by not spreading through the blood sinuses, by not adhering to the exuviae at molting, and by remaining visible through repeated moltings of one growing season. A variety of materials, both liquid and solid, were tried for marking purposes, but this ink proved the most successful.

933. Kimsey, J. B. and Gerald R. Holman. 1955. A SIMPLE TRAP METHOD FOR RESCUING FINGERLING SALMONIDS. The Prog. Fish-Cult., Vol. 17, No. 1, Jan., pp. 39-40.

The runoff pattern of many north-central streams in California is such that annual rescue of fingerling salmonids is necessary. Seining and shocking proved impractical in the smaller rocky streams. Live cars, approximately 2 feet by 3 feet by 2 feet deep, constructed of 1/8-inch hardware cloth through which the total low flow is diverted by constructing a small dirt-and-rock dam with a 4-inch outflow pipe, proved to be considerably more effective than former methods. One crew in 1952 using this method rescued almost six times as many steelhead and silver salmon fingerlings as the same crew rescued from the same streams in 1951.

934. Walker, Charles R. 1955. A MODIFICATION OF THE KEMMERER WATER BOTTLE FOR SAMPLING SHALLOW WATERS. The Prog. Fish-Cult., Vol. 17, No. 1, Jan., p. 41.

Modifications, made to permit use of the water sampler in a horizontal position, involve springs to hold stoppers firmly in closed position, metal straps on the barrel for attaching a rope bridle, and alteration of trip mechanism for closing sampler with a jerk of a rope.

935. Prevost, Gustave. 1955. MANAGEMENT OF QUEBEC TROUT LAKES. Trans. Twentieth N. A. Wildlife Conf., March, pp. 252-262.

The concept of fish conservation is quite different today from what it was in the past. Today we try to make maximum use of our renewable fish resources and not let fish die of old age. So the tendency is to liberalize fishing policy, instead of restricting it.

This policy has, of course, to be built on solid grounds, and to get maximum results we will have to consider each lake individually, the way an agronomist manages a portion of land. Seeing how vast is the number of lakes in this province, we realize that it is not going to be easy to put the new policy into effect. But it should be done.

When that time comes, many of the present regulations will have to change. For instance, instead of a day bag limit there will be a year bag limit. Because what is important is the annual crop. And this in turn will be largely determined by what our research is bringing to light about size limits, stocking, food, dams and pollution.

To prepare the way for these changes, biologists must bring these new concepts home to the public, doing so through newspapers, radio, television, etc. Anglers then will have a clear idea of new methods that will benefit the sport, and will ask the government to adopt them. (A)

936. Martin, N. V. 1955. THE EFFECT OF DRAWDOWNS ON LAKE TROUT REPRODUCTION AND THE USE OF ARTIFICIAL SPAWNING BEDS. Trans. Twentieth N. A. Wildlife Conf., March, pp. 263-271.

The investigations of water-level fluctuations and lake trout reproduction that have been carried out to date point out the fact each lake is a separate problem. Levels fluctuate differently from lake to lake and year to year in one lake. In addition the trout spawn at different depths in various lakes. Lowering of water levels before spawning is of limited value, at least in the lakes that have been studied, as there may be no available spawning areas when they are required. Furthermore, with this practice the lake trout may be forced to spawn on unfavorable areas where egg loss may be high. Use of echo sounders and diving equipment to locate possible rocky areas in deeper waters is desirable. It will be difficult to estimate the effects of various lake levels on egg depositions without this information. A check of the age composition of the lake trout populations in the storage lakes through a creel census may also be of value and give positive evidence of the effect of drawdowns.

The Hydro-Electric Power Commission cooperates in water level manipulation as far as is possible within the limits of its water requirements. However, in an exceptionally dry year drawdowns may be severe. The use of artificial spawning beds may be of use in circumventing situations where harmful drawdowns cannot be avoided. Obviously many situations will not lend themselves to their use. The cost of construction of artificial beds of

course will vary considerably with such things as the accessibility of the lake, the cost and availability of a rock supply, hauling distances, labor rates, etc.

The present problem is to make the lake trout spawn on the unused spawning beds. Use of a bed near where some previous spawning had occurred may indicate they have either become familiar with this area over a period of time or it has some characteristic odor which attracts them to it. An attempt will be made in 1955 to attract trout to the other beds by penning mature fish on the beds or introducing some odor such as milt. If this succeeds, it may allow a greater choice of sites for artificial beds with a corresponding reduction in cost.

937. Reid, Kenneth A. 1955. INCREASING SUMMER STREAMFLOW. Trans. Twentieth N. A. Wildlife Conf., March, pp. 229-241.

Low water and high temperature are weak links in the growth and production of trout. Summer low flows can be multiplied by storage of high flows in natural lakes and ponds and other depressions. Merely restricting a lake's outlet will result in moderation of flow extremes; a pipe-and-valve control structure and modifications to draw cool bottom water increase these benefits. A series of low dams may be useful. Increased summer streamflow benefits the public in many ways in addition to fishing. Such flow regulation is marketable to power companies making the structures self-liquidating. Flood hazards are reduced. Three years of observation of the first major development involving a watershed of 66 square miles shows a great increase in the trout population.

938. Miller, Richard B. 1955. TROUT MANAGEMENT RESEARCH IN ALBERTA. Trans. Twentieth N. A. Wildlife Conf., March, pp. 243-252.

The causes of poor returns of stocked trout and their failure to overwinter were investigated. The poor survival of hatchery-reared fish, superimposed on a resident population was found to be to some degree a function of fish size at least during the season of planting. When hatchery trout were larger than resident trout, 65 percent survived the summer; when the same size or smaller than resident fish, survival was only 15 to 34 percent. More than half this mortality occurs in the 10 days following planting. Survival over winter was negligible for all sizes.

Survival of wild trout superimposed on a resident population was better than for the hatchery fish. Mortality over the first summer was less than 10 percent with negligible over-winter survival. Weight losses were less than for hatchery fish and were regained after 30 to 50 days. Trout, raised in a hatchery but held for 10 to 18 months in a natural stream before planting, exhibited weight losses and mortality intermediate between hatchery and wild stocked trout.

As hatchery trout stocked in a reach from which the resident population had been removed exhibited high survival and gained in weight, competition seems to be the important causative factor. Weight loss occuring in all superimposed trout must be entirely due to competition. Mortality, however, cannot be attributed solely to competition, as 13 to 16 percent died in the absence of competition. This percentage must have died as a direct result of physical forces in the stream. Presumably the additional 40 percent that died when competition was present also succumbed to physical forces, but only because prior occupancy of favorable niches forced them to remain in the current. Death is possibly caused by exhaustion. Low over-wintering survival is probably a result of weight loss, which in itself is a result of competition.

939. Davison, Verne E. 1955. FISH CULTURES FOR AGRICULTURAL WATERS. Trans. Twentieth N. A. Wildlife Conf., March, pp. 272-277.

This paper discusses the fish cultures needed for several types of impounded waters and outlines the cultural problems to be solved. It is limited to the management of agricultural waters.

940. Elson, P. F. and C. J. Kerswill. 1955. STUDIES ON CANADIAN ATLANTIC SALMON. Trans. Twentieth N. A. Wildlife Conf., March, pp. 415-426.

The lack of relationship between size of catches of parents and offspring year-class catches for the past 85 years, the beneficial effect of merganser and kingfisher control on parr and smolt populations, the fisheries of the New Brunswick, Nova Scotia, and Newfoundland areas, the determination of fingerling stocking rates to produce greatest numbers of yearling parr and smolt, the number of female salmon needed to maintain stocks, and the harmful effects of DDT spraying on salmon are discussed.

941. Neave, Ferris and R. E. Foerster. 1955. PROBLEMS OF PACIFIC SALMON MANAGEMENT. Trans. Twentieth N. A. Wildlife Conf., March, pp. 426-440.

The production of as great a harvestable surplus as possible is the chief objective salmon management. Problems presently hampering the attainment of this objective and course of action to be followed to overcome these problems are discussed. Heavy mortality during both fresh and salt water phases suggest the importance and large reward of any measure which will reduce mortality.

942. Hourston, W. R., C. H. Clay, L. Edgeworth, P. A. Karkin, E. H. Vernon, and R. G. McMynn. 1955. PLANNING ANADROMOUS FISH PROTECTION FOR PROPOSED DAMS. Trans. Twentieth N. A. Wildlife Conf., March, pp. 440-454.

The problems encountered in providing suitable passage for fish and how each was handled at Cleveland Dam on the Capilano River, British Columbia, are described.

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